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WORLD TRENDS IN PASSENGER-CAR PRODUCTION AND ENGINES 1978

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SEPTEMBER 1978

78-3

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FOREWORD

This report on world trends and the factors affecting them in passenger-car production, car exports, and various aspects of car and engine design is our fourth, following previous ones in 1964, 1967, and 1975.

PRODUCTION

The 1977 production of passenger cars, trucks and buses, and total vehicles by the top 20 car-producing countries is listed in Table 1. In addition, the trends from 1967 to 1977 for the ten major car-producing countries are shown in Figure 1 for total car, truck, and bus production and in Figure 2 for car production alone.

Brazil

Brazil has risen to one of the top 10 car-producing nations from a modest beginning two decades ago when Volkswagen do Brasil assembled 370 Microbuses and Transporters in 1957. In the early 1960's, VW was joined by Alfa Romeo's Fabrica Nacional, Simca, and Willys-Overland do Brasil, which had a license to build Renault models. Subsequently, Brazilian car production was spurred by three events in 1967-68. In 1967, Chrysler acquired Simca do Brasil and Ford Motor, which had been producing trucks in Brazil, purchased Willys-Overland and added the Ford Galaxie 500 to the product line. Then, in 1968, General Motors, another truck producer in Brazil, commenced producing the Opala — a version of GM's German Opel. Since then, all manufacturers have added car models to their product lines.

The result has been a steady rise in motor vehicle production from 225,000 vehicles (170,000 cars) in 1967 to 985,000 vehicles (827,000 cars) in 1976. Production declined slightly in 1977 to 919,000 vehicles (773,000 cars) largely because of reduced domestic sales resulting from increased government credit restrictions (minimum down payment raised from 20% to 30% and loan length reduced from 36 months to 24 months) and higher car and gasoline prices. VW's dominance in car production (72% in 1967) is being challenged by General Motors, Ford, and, most recently, Fiat. In the early 1970's, GM introduced the Chevette, sister car to GM's German Kadett and Japan's Isuzu Gemini, and Ford brought out the Corcel. And in 1976, Fiat commenced production of the Fiat 147 (based on the 127) in its new plant in Betim near

TABLE 1

1977 Motor Vehicle Production

Top 20 Car-Producing Countries

Country	Production/1000 Cars	Trucks & Buses	Total
United States	9,214	3,489	12,703
Japan	5,431	3,083	8,514
West Germany	3,790	314	4,104
France	3,565	441	4,006
Italy	1,441	143	1,584
Great Britain	1,328	386	1,714
USSR (Est.)	1,280	734	2,014
Canada	1,162	613	1,775
Spain	989	141	1,130
Brazil	773	146	919
Australia	369	84	453
Belgium	301	55	356
Poland	294	80	374
Sweden	235	52	287
Yugoslavia	231	27	258
Mexico	188	93	281
Argentina	168	67	235
East Germany	164	36	200
Czechoslovakia	159	39	198
Holland	54	13	67
Others	179	249	428
World Total	31,315	10,285	41,600

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Belo Horizonte. In 1977, VW's share of car production had dropped to 60%, followed by GM (16%), Ford (13%), and Fiat (8%). Fiat's share will almost certainly grow as Fiat 147 production increases to the plant design level, with a new model based on the Fiat 128 scheduled to be added.

Canada

Canada's production rose from 919,000 vehicles (708,000 cars) in 1967 to 1,575,000 vehicles (1,227,000 cars) in 1973 before dropping slightly to 1,424,000 vehicles (1,045,000 cars) in 1975, primarily as the result of the 1973 energy crisis. Since then, production has risen to a new high of 1,775,000 vehicles (1,162,000 cars) in 1977. Since Canada exports and imports a relatively small number of units except for its tariff-free trade with the United States, its production trends reflect domestic and U.S. demand.

France

Vehicle production in France rose steadily from 2,010,000 vehicles (1,777,000 cars) in 1967 to a record high of 3,596,000 vehicles (3,202,000 cars) in 1973. Since then, production dipped to 3,299,000 vehicles (2,953,000 cars in 1975) before recovering to set a new record of 4,006,000 vehicles (3,565,000 cars) in 1977. The more than double increase in annual production since 1967 has moved France into close contention to West Germany for the No. 3 spot in world production behind the United States and Japan (French car production actually exceeded West German car production in 1974 and 1975). As will be discussed later, France's rise stems largely from aggressive expansion of the export market, with car exports increasing at an even faster rate than the domestic market.

West Germany

West Germany's production rose from 2,482,000 vehicles (2,296,000 cars) in 1967 to 3,949,000 vehicles (3,650,000 cars) in 1973. However, production fell by 22% to 3,100,000 vehicles (2,840,000) cars in 1974 as a result of a combination of reduced domestic demand and losses in the export market. Since then, however, production has rebounded to a record high of

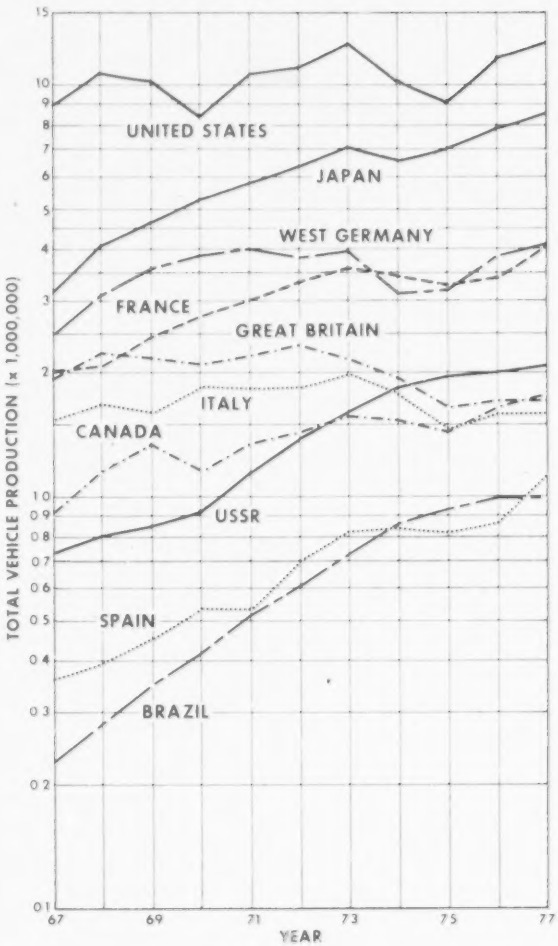

Figure 1. Trends in Production of Cars, Trucks, and Buses in Ten Major Car-Producing Countries

4,104,000 vehicles (3,790,000 cars) in 1977, with both domestic sales and exports recovering strongly.

Great Britain

In 1964, when production of 2,332,000 vehicles (1,888,000 cars) set a record that still stands, Great Britain ranked as the No. 3 vehicle producer in the world behind the United States and West Germany. After dropping to 1,937,000 vehicles (1,552,000 cars) in 1967, production rose to a near-record level of 2,329,000 vehicles (1,921,000 cars) in 1972. Since then, however, production has declined to 1,714,000 vehicles (1,328,000 cars) in 1977. As a result, Great Britain now ranks No. 7 in total vehicle production (behind the U.S., Japan, West Germany,

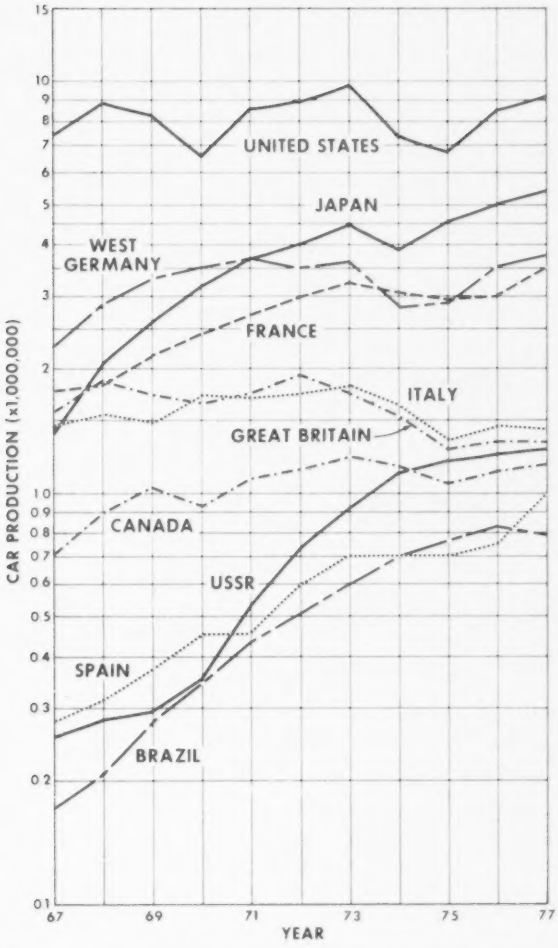

Figure 2. Trends in Passenger-Car Production in Ten Major Car-Producing Countries

France, USSR, and Canada) and No. 6 in car production (behind the U.S., Japan, West Germany, France, and Italy). The decline in Great Britain stems from a combination of production-crippling labor disputes, a declining share of the world export market, and increasing competition from imports (car imports exceeded exports for the first time in 1976, with imports taking 45% of new-car sales in Great Britain in 1977).

Italy

In Italy, production rose from 1,543,000 vehicles (1,439,000 cars) in 1967 to 1,958,000 vehicles (1,823,000 cars) in 1973 before declining to a near-1967 level of 1,584,000 vehicles (1,441,000 cars) in 1977. Like Great Britain, Italy has been plagued by frequent strikes, with car imports rising faster than exports during the past decade (car imports up 239% from 1967 to 1977, compared to a 59% rise for car exports).

Japan

Except for a brief drop in production in 1974 when domestic sales slumped due to a massive rise in fuel price, higher car prices, and higher car taxes, Japan's vehicle production has risen steadily and sometimes dramatically. Starting with 3,147,000 vehicles (1,376,000 cars) in 1967, production rose to 7,083,000 vehicles (4,471,000 cars in 1973, dropped to 6,552,000 vehicles (3,932,000 cars) in 1974, and then climbed to 8,514,000 vehicles (5,431,000 cars) in 1977. Japan's increase in car production has largely resulted from aggressive exporting throughout the world, with exports accounting for over two-thirds of the increase in car production from 1967 to 1977.

Spain

Production growth in Spain has paralleled that in Brazil at a somewhat higher level. From 363,000 vehicles (275,000 cars) in 1967, production has more than tripled in the last decade to 1,130,000 vehicles (989,000 cars) in 1977. The primary contributor to the growth in the first half of the decade was Seat, which started as an assembly plant 36% owned by Fiat in 1953 and now builds models under Fiat license. In the past five years, however, Fasa-Renault, Citroen Hispania (which assembles the 2CV, Ami 6, Dyane, GS, and Mehari), Chrysler Espana, and, most recently, Ford Espana have become important cogs in Spain's car production. In 1972, Seat produced 59% of the cars, followed by Fasa-Renault (21%), Chrysler (10%), and Citroen (7%). In 1977, Seat's production share had dwindled to 35%, followed by Fasa-Renault (23%), Ford (22%), Citroen (11%), and Chrysler (10%). Ford, which had entered production in Spain in late 1976 when it started assembling the Fiesta, produced 201,000 Fiestas in its first full year of operation (by law, Ford must export all cars in excess of 10% of Spain's new car registrations each year). And Renault began production in a new plant in Palencia early this year.

United States

Starting with production of 9,024,000 vehicles (7,413,000 cars) in 1967, production rose to 10,820,000 vehicles (8,849,000 cars) in 1968 before declining to 8,284,000 vehicles (6,550,000 cars) in 1970 under the effects of a mild recession. Subsequently, production climbed to a record high of 12,681,000 vehicles (9,667,000 cars) in 1973. Production again dropped to 8,987,000 vehicles (6,717,000 cars) in 1975 under the combined impact of the early 1974 energy shortage, mid-1974 strikes, buyer resistance to higher prices, and an economic recession. Since then, however, buyers apparently realized that high prices are here to stay and expanding sales drove production to 12,703,000 vehicles (9,214,000 cars) in 1977 – a record year for total vehicle production and second only to 1973 in car production.

USSR

USSR production rose gradually from 729,000 vehicles (251,000 cars) in 1967 to 922,000 vehicles (352,000 cars) in 1970, with cars being used primarily by top government officials, doctors, and the military. However, negotiations during the 1960's led to the opening of the Fiat-built plant in Togliatti in 1970 producing a modified version of the Fiat 124. Called the Zhiguli in Russia and the Lada in other countries, this provided a people's car for domestic use and a car for the export market (Russia now exports about 40% of these cars to other countries under the Lada name). As a result, car production more than tripled from 1970 to 1977, rising to an estimated 1,280,000 cars out of 2,014,000 vehicles produced.

EXPORT–IMPORT

Prior to the mid-1960's, four of the major car-producing countries – France, West Germany, Great Britain, and Italy – were the leading car exporters, relying heavily on their export markets to maintain or increase their car production. In 1967, West Germany was the unquestioned leader (1,362,000 cars), followed by France (738,000 cars), Great Britain (500,000 cars), and Italy (404,000 cars). In the past decade, however, the pattern has changed. Japan, which began aggressively expanding into the export market in the mid-1960's, has increased its car exports over ten-fold, rising from 224,000 cars in 1967 to 2,959,000 cars in 1977. As a result, its 1977 share of the car export market was about 50% greater than that of France (2,084,000 cars). France, which has increased its car exports at a rate second only to Japan, has joined West Germany (1,939,000 cars) as a major force in the world market. In the meantime, Great Britain and Italy have fallen behind by maintaining or only slightly increasing their export markets.

In the European trade market, a major factor is the European Economic Community (EEC). Originally comprising France, West Germany, Italy, Belgium, Luxembourg, and Holland, the EEC gradually eliminated tariffs until they were completely removed in 1968. On January 1, 1973, Great Britain, Denmark, and Ireland, joined the EEC. Prior to that time, Great Britain and Denmark had belonged to the European Free Trade Association (EFTA), which included Austria, Norway, Portugal, Sweden, and Switzerland.

Canada is not included in our discussion because Canada and the United States provide a unique bilateral situation. Looking at cold statistics, the two countries would surpass Great Britain and Italy as car exporters, with 1977 exports being 918,000 for Canada and 697,000 for the U.S. However, these exports almost entirely result from the dropping of tariff between Canada and the U.S. in 1965. In 1977, 91% of Canadian car exports went to the U.S. and 84% of U.S. car exports went to Canada.

On imports, the United States has remained the dominant car-importing country during the past decade. However, other countries are rapidly growing as importers of the world cars.

Figure 3 shows the trends in car exports and imports for the six major car-producing countries from 1967 to 1977.

France

Starting as a distant second behind West Germany, France has more than doubled its export market in the last decade, with exports rising from 738,000 cars (42% of production) in

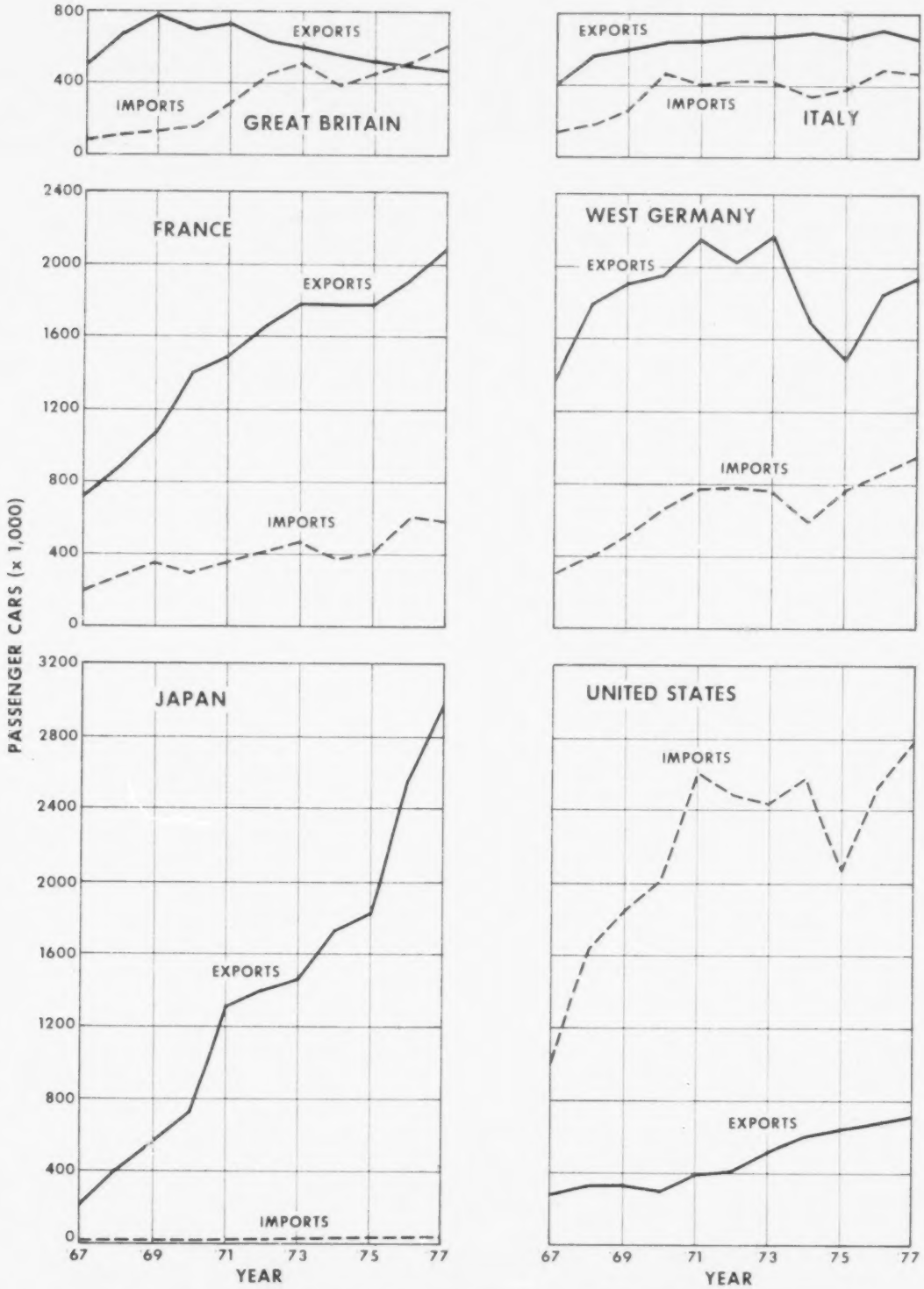

Figure 3. Trends in Passenger-Car Export and Import in the Six Major Export-Import Countries

1967 to 2,084,000 cars (58% of production) in 1977. Over 80% of France's exports go to other European countries.

Car imports by France have risen at about the same rate as exports, from 185,000 cars in 1967 to 582,000 cars in 1977. As a result, car imports have remained at about 25% of exports during the past decade. In 1977, most of France's imports came from three countries – West Germany (28%), Spain (27%), and Italy (16%).

West Germany

From 1967 to 1974, West Germany exported 55% to 62% of its car production, with the export share dropping slightly to 51% of production for 1975-77. Thus, car exports have followed the production curve, rising from 1,362,000 in 1967 to 1,939,000 in 1977. During the decade, however, West Germany lost its position as the leading car exporting country. In 1967, West Germany exported nearly twice as many cars as its nearest competitor – France. Since then, aggressive exporting by France and Japan has cut deeply into West Germany's share of the world market. Japan surpassed West Germany in 1974 and has established a comfortable lead as the largest car exporter, while France is vying with West Germany for the No. 2 position. This competition and the world economic condition caused West Germany's car exports to fall by 21% from the record level of 2,173,000 in 1973 to 1,476,000 in 1975, before rebounding to the 1977 level. Of the 1,837,000 cars exported in 1976, 49% went to other EEC countries, including France (12%), Italy (9%), and Great Britain (8%), with Europe as a whole taking 72%.

The United States market has been a major factor in West Germany's surrendering export leadership to Japan. Although the U.S. remained West Germany's best customer in 1976 (19% of car exports), West Germany's domination of the U.S. import market in the 1950's and 1960's (largely because of Volkswagen) was successfully challenged by Japanese car manufacturers in the late 1960's. As a result, U.S. car imports from Japan slightly surpassed those from West Germany in 1972 (698,000 vs. 677,000). Although West Germany briefly reclaimed the lead in 1973, Japan has opened up an increasingly wider gap since then. In 1976, Japan claimed 44% of the U.S. import market, compared to 14% for West Germany.

Car imports by West Germany also have risen during the past decade from 324,000 cars in 1967 to 949,000 cars in 1977. Of the 854,000 cars imported in 1976, 91% came from other EEC countries, with 24% from France, 45% from Belgium, and 18% from Italy. West Germany imported 48,000 cars (6% of imports) from Japan in 1976.

Great Gritain

Great Britain's inability to expand its car export market has been one of its major industrial problems. Car exports rose from 500,000 (32% of production) in 1967 to a peak of 772,000 (45% of production) in 1969, before declining to 475,000 (36% of production) in 1977, the lowest level since 1961. By comparison, car imports have risen from 93,000 in 1967 to 698,000 in 1977, 47% above car exports. Car imports exceeded exports for the first time in 1976, with imports of 522,000 cars and exports of 496,000 cars.

Of the 475,000 cars exported in 1977, only 27% went to other EEC countries, notably Ireland (8%) and Holland (6%). The major market was Iran (21%), followed by the United States (11%), South Africa (6%), and New Zealand (5%). By comparison, 69% of the 698,000 cars imported in 1977 came from other EEC countries, primarily West Germany (25%), France (21%), and Italy (13%). West Germany's lead in Great Britain is being challenged by Japan, which claimed 24% of the British car imports in 1977.

Italy

Starting with 404,000 cars (28% of production) exported in 1967, Italy's car exports rose to 632,000 (37% of production) in 1970. Since then, there has been little change, with car exports reaching a peak of 696,000 (47% of production) in 1976 before dropping to 644,000 (45% of production) in 1977. Car imports have followed a somewhat similar path, rising from 141,000 in 1967 to 460,000 in 1970 and 487,000 in 1976 before declining slightly to 479,000 in 1977.

Of the 644,000 cars exported in 1977, 61% went to other EEC countries led by West Germany (19%), Great Britain (14%), and France (14%). The United States took 9% of Italy's car exports in 1977. Over 90% of Italy's car imports come from France and West Germany.

Japan

Japan's ascendancy in the car export market has contributed largely to its dramatic rise in car production. Japan's rise to the top started in the mid-1960's. A decade ago, in 1967, Japan's car exports had risen from a 1962 level of 16,000 cars to 224,000 cars (16% of production). Since then, car exports have increased over 1200% to 2,959,000 (54% of production).

Japan's rise in the world market stems from active participation in all areas. In 1977, the Americas took 54% of Japan's car exports, with 22% going to Europe, 12% to Asia, 7% to Oceania, and 4% to Africa. Among countries, the United States led the way with 45% (1,326,000 cars), followed by Australia (6%), Great Britain (5%), Canada (4%), and Holland (4%).

Japan's car imports have remained low, ranging from 14,000 cars in 1967 to 45,000 cars in 1975. Of the 42,000 cars imported in 1977, 49% came from West Germany.

United States

Prior to 1965, U.S. car exports amounted to only 2-3% of car production. With the dropping of tariff between Canada and the U.S. in 1965, the export percentage rose from 3.8% in 1967 to 9.5% in 1975 before dropping to 7.6% in 1977. Of the 697,000 cars exported in 1977, 84% went to Canada.

U.S. car imports rose sharply from 1,020,000 cars in 1967 to 2,587,000 cars in 1971 before dropping to 2,075,000 cars in 1975. Since then, imports have rebounded to a new high of 2,790,000 cars in 1977. Of the 2,537,000 cars imported in 1976, over 90% came from three countries – Japan (45%), Canada (33%), and West Germany (14%).

ENGINE

A statement we made in our first analysis in 1964 bears repeating again: "Even if you disregard the aspects of car size, style, and chassis design, the car buyer in the world market has a wide selection to choose from. He can get an engine in the front, driving the front or rear wheels, or in the rear. He can have his choice of 2, 3, 4, or 6 cylinders arranged inline, 2, 4, or 6 cylinders horizontally opposed, or 2, 4, 6, 8, or 12 cylinders in a Vee. He can order a diesel engine, a two-stroke-cycle gasoline engine, or a four-stroke-cycle gasoline engine with or without fuel injection. Or he can have the engine cooled by water or air."

However, the mix in 1978 is quite different from that in 1964. For example, a car buyer will not find it as easy to find a car with a two-cycle engine. The demise of the Glas Goggomobile and the Auto Union DKW F102 and the adoption of a four-cycle V-4 by Saab for its "95" and "96" models in Sweden means that the only place he can find a domestically produced two-cycle car in Europe is in East Germany (inline three-cylinder Wartburg and transverse two-cylinder Trabant front wheel-front drive cars) or Poland (inline three-cylinder Syrena front wheel-front drive). In Japan, his choice is now limited to the Suzuki Fronte 7-S (a rear-engine car with a transverse three-cylinder engine) since Daihatsu Kogyo, Fuji (Subaru), and Mitsubishi have all dropped their two-cycle engines in their mini cars in favor of four-cycle engines. On the other hand, the car buyer has available a few offerings that were not available in 1964, including mid-engine-rear drive cars, rotary engines, and five-cylinder engines. And he has a much wider choice of diesel-powered cars and front-wheel-drive cars.

In the following sections, we will discuss trends in engine location, type, and design within the world as a whole and individual nations. Canada is not included in these discussions, since the character of its car design closely parallels that in the United States.

Engine Location and Drive

In 1967, we said, "During the last three years, the major car-producing nations have shown

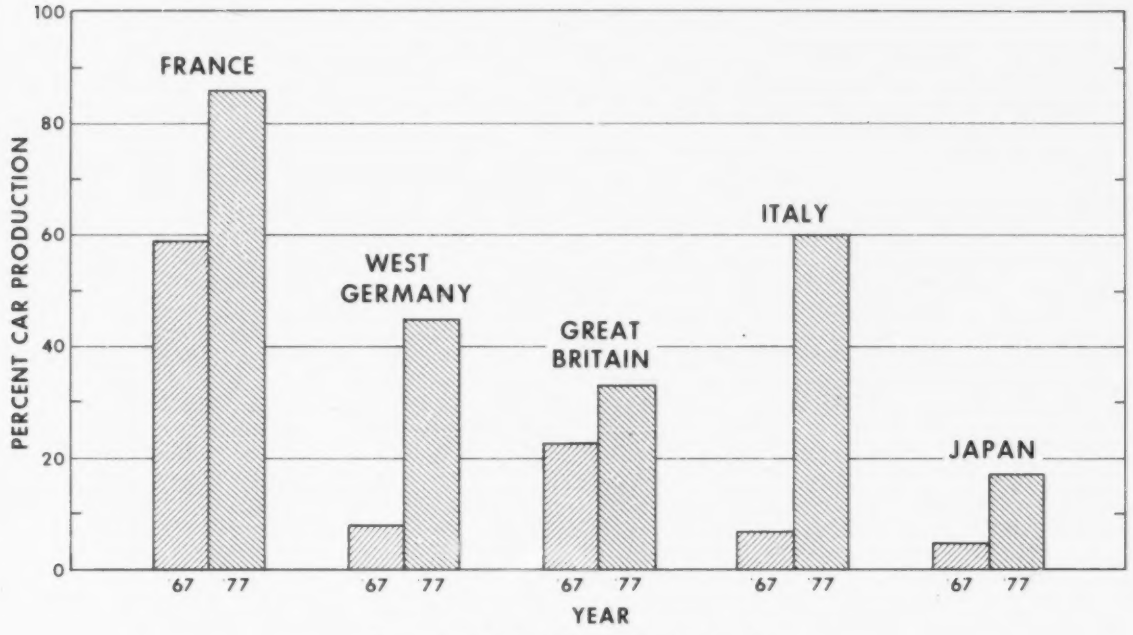

Figure 4. Trends in Front-Wheel-Drive Cars.

togetherness in at least one area of car design – a growing number of front-wheel-drive cars." But we did not anticipate the dramatic growth in front-wheel-drive cars during the past decade.

Figure 4 shows the percentage of cars produced using front wheel drive in 1967 and 1977 in France, Italy, West Germany, Great Britain, and Japan.

France – Citroen has been totally committed to front wheel drive for many years (since 1934), and Renault broke away from its rear engine-rear drive pattern in 1961 to produce the R4, followed by the R16 and its longitudinally mounted 1470-cc engine in 1965. Also in 1965, Peugeot, which had previously produced front engine-rear drive cars, brought out the 204 model with a transversely mounted 1130-cc engine. And Chrysler France, which had produced both front engine-rear drive and rear engine-rear drive models, started driving the front wheels in 1967 with the Simca 1100. As a result, front-wheel-drive cars represented 59% of France's car production in 1967.

Since 1967, Renault has converted completely to front-wheel drive, and front-wheel-drive models have been added by Chrysler France (Simca 1307 and 1308 in 1975 and Simca Horizon in 1977) and by Peugeot (304 in 1969, 104 in 1972, and 305 in 1977). The result – France is easily the leading country in producing front-wheel-drive cars, with these cars representing 86% of car production in 1977.

West Germany – Audi (then Auto Union) produced the first front-wheel-drive car in Germany in 1933 when a six-cylinder engine was used in the Front UW and has maintained this drive-wheel design on all models since then. Ford joined Audi as a producer of front-wheel-drive cars in 1962 with the Taunus 12M. In 1967, Auto Union's Audi 70, 80, and 90 and Ford's Taunus 12M and 15M accounted for only 8% of West Germany's car production.

Since 1967, Ford dropped the front-wheel drive Taunus 12M and 15M but reentered the front-wheel-drive field with the Fiesta in 1976. Volkswagen, which had previously produced cars with rear-mounted air-cooled engines driving the rear wheels, first broke with tradition by offering the front-wheel-drive K70 with a liquid-cooled inline four in 1970. This was followed by the Passat (Dasher in U.S.) in 1975, Scirocco and

Golf (Rabbit in U.S.) in 1974, Polo in 1975, and Derby in 1977. As a result, all of Volkswagen's domestic cars for 1978 are front-wheel-drive models powered by transversely mounted four-cylinder liquid-cooled engines except for the 1303, with the last of the horizontally opposed air-cooled fours mounted in the rear. Thus, in 1977, the Ford-Audi-VW front-wheel-drive cars accounted for 45% of German car production.

Porsche departed from the tradition of air-cooled rear-mounted engines in 1976 when it brought out the 924 with its liquid-cooled inline four and front engine-rear drive layout and followed it with a liquid-cooled V-8 for the front engine-rear drive 928 in 1977.

Great Britain – British Motor (now British Leyland) introduced its front-wheel-drive Austin/Morris Mini with transversely mounted four-cylinder engine in 1959. Its success spawned a family of front-wheel-drive cars, including the Austin, Morris, and MG 1100's and the Austin/Morris 1800. Triumph (also now part of British Leyland) brought out the front-wheel-drive 1300 in 1965. This combination claimed 23% of Great Britain's car production in 1967.

Since its formation in 1968, British Leyland added (and later dropped) the Austin/Morris 2200 models powered by a transversely mounted six-cylinder engine and the Austin Maxi (in 1969) and Allegro (in 1973) models powered by four-cylinder transverse engines. British Leyland also converted the Triumph 1500 (successor to the 1300 model) to a front engine-rear drive car in 1974.

Until 1976, British Leyland was the only producer of front-wheel-drive cars in Great Britain. However, Ford (England) produced its first front-wheel-drive car – the Fiesta – in 1976 and Chrysler UK joined with the Alpine in 1977, with both using transverse engines. The resulting combination accounted for 33% of Great Britain's car production in 1977.

Italy – In the early 1960's, the only Italian car manufacturers using front-wheel drive were Innocenti, which produced models based on British Motors Minis, and Lancia, which had just introduced Fulvia models with V-4 engines and Flavia models with four-cylinder horizontally opposed engines. Autobianchi joined the front-wheel-drive clan in 1964 with the Primula powered by an in-line four. In 1967, these front-wheel-drive cars represented 7% of Italy's car production.

Since 1967, Lancia has converted to all front-wheel-drive cars except for the mid engine-rear drive Beta Montecarlo and Stratos – low-production rally cars. Autobianchi added the A 112 in 1969. Fiat entered the front-wheel-drive field in 1969 with the 128, followed by the 127 two years later. Both are powered by four-cylinder transverse engines. And Alfa Romeo started production of the front-wheel-drive Alfasud with its four-cylinder horizontally opposed engine in 1972. In 1977, the production share for front-wheel-drive cars in Italy had climbed to 60%, second only to France.

Japan – In Japan, Fuji Heavy Industries showed the way in front-wheel-drive cars by introducing the Subaru 1000, powered by a 977-cc horizontally opposed four, at the Tokyo show in the fall of 1965. In 1967, Honda followed with the N360, a tiny four seater powered by a transverse twin 354-cc engine, and Suzuki introduced the Fronte 360 (inline two) and 800 (inline three). In 1967, these front-wheel-drive cars took only 5% of Japan's car production.

Since 1967, Fuji replaced the Subaru 1000 in 1971 with the front-wheel-drive Leone, Honda replaced the N360 with the Life (later dropped) in the same year, followed by the Civic (1972) and, more recently, the Accord. As a result, Honda now produces only front-wheel-drive cars. Nissan brought out its first front-wheel-drive car – the Datsun Cherry powered by a 1-litre transverse four – in 1970. Daihatsu Kogyo replaced the front engine-rear drive Fellow with the front-wheel-drive Fellow Max (356-cc transverse twin) the same year, later replaced the Fellow Max with the Max Cuore (547-cc transverse twin), and added the Charade (993-cc transverse three) in 1977. The result – the front-wheel-drive share of car production in Japan increased to 17% in 1977.

And that share will increase substantially in the future. Since the first of this year, new front-wheel-drive models entering production in Japan include Isuzu's Florian, Mitsubishi's Mirage,

Nissan's Pulsar, and, most recently, Toyota's Tercel and Corsa models. The first three use transverse fours. The Tercel and Corsa are unique among front-drive Japanese cars by using longitudinally mounted four-cylinder engines.

United States – Oldsmobile became the first U.S. manufacturer to produce a front-wheel-drive car since the last Cord was built in the 1930's when it introduced the Toronado for 1966, with a longitudinally mounted V-8 engine. Cadillac followed suit for 1967 with the Eldorado. These models remained the only mass-produced front-wheel-drive cars in the U.S. until the fall of 1977 when Chrysler introduced the Plymouth Horizon and Dodge Omni – the first U.S.-built compact cars with front wheel drive. These cars will be joined this fall by the front-drive Buick Riviera powered by a 5.7-litre V-8 or a turbocharged 3.8-litre V-6 and early in 1979 by a Chevrolet front-drive compact in which buyers will have a choice of either a 2.5-litre four or a 2.8-litre V-6. And Ford is planning a front-wheel-drive Pinto for 1981.

Other Countries – In Sweden, Saab continues its long-standing front-wheel-drive tradition, while Volvo continues to build front engine-rear drive cars. Spain's front-wheel-drive cars are the Fasa-Renault line, Chrysler's Simca 1200, and the Seat 127 and 128 models in the Fiat mold.

In Eastern Europe, East Germany is totally front wheel drive, with the Wartburg powered by a two-cycle inline three patterned after the pre-World War II DKW and the Trabant using a two-cycle air-cooled transverse twin. Like the Wartburg, Poland's Syrena uses an air-cooled two-cycle inline three. And Yugoslavia's Zastava 101 is derived from the Fiat 128.

South America's front-wheel-drive production has grown in recent years with Argentina's Fiat Concord 128 and 1300 TV and Brazil's Fiat 147L, Ford Corcel, and Volkswagen Passat.

Mid Engine-Rear Drive – In recent years, car manufacturers have added a fourth engine-drive arrangement – the mid engine-rear drive. This layout, in which the engine is mounted well forward of the rear axle, is currently limited to sports models where the performance benefit outweighs the loss in rear passenger accommodation. Current cars using this layout include Great Britain's Lotus Esprit, France's Matra Simca Bagheera, and Italy's Ferrari Dino, Fiat X 1/9, Lamborghini Urraco and Silhouette, Lancia Beta Montecarlo and Stratos, and Maserati Merak and Kyalami.

Engine Type

During the past decade, the world has come to even more agreement in two areas – engine coolant and combustion cycle. Although liquid was the preferred coolant for most engines in 1967, air was commonly used for small engines (less than 1 litre) in France by Citroen (2 CV, 3 CV, Ami 6, and Panhard), in West Germany by BMW (Glas Goggomobile) and NSU on all models except the rotary-engined Spider, in Italy by Autobianchi (Bianchina) and Fiat (500), in Holland by all DAF models, and in Japan by Fuji (Subaru 360), Honda (N360), Mitsubishi (Minica), Suzuki (Fronte 360), Toyo Kogyo (Mazda R360), and Toyota (Publica and Sports 800). In addition, West Germany's Porsche and Volkswagen used air-cooled engines in all their cars and the U.S. had the air-cooled Chevrolet Corvair.

Today, Citroen continues to use air-cooled horizontally opposed two-cylinder (435 and 602 cc) and four-cylinder (1129 and 1222 cc) engines in France. In West Germany, however, air-cooled engines have nearly disappeared. The Glas Goggomobile is no longer produced, NSU has switched completely to liquid-cooled engines, Volkswagen now uses liquid-cooled engines in all models except the 1303, and Porsche broke with tradition when it introduced the liquid-cooled 924 in 1976. Italy's Fiat 126 (652 cc) is Italy's sole air-cooled car. Holland's Volvo models (formerly DAF) all now use liquid-cooled engines. Japan also has converted completely to liquid-cooled engines.

For combustion, two-cylinder or three-cylinder inline engines of two-cycle design were used in 1967 in West Germany for the Glas Goggomobile and Auto Union DKW F102, in Sweden for all Saab models except the 96 V-4, and in Japan for the Daihatsu Kogyo Fellow, Fuji Subaru 360, Mitsubishi Minica and Colt 800, and Suzuki Fronte 360 and 800. Today, only the Suzuki Fronte is powered by a two-cycle engine. In

Europe, a car buyer who wants a two-cycle engine must go to East Germany (Trabant and Wartburg) or Poland (Syrena 105).

In cylinder arrangement, the four-cylinder in-line remains the dominant type in major car-producing countries except for Canada and the United States, where the V-8 prevails. However, the mix has changed during the past decade.

France – France has remained almost totally in-line four-cylinder engines. Citroen continues to use two cylinders horizontally opposed for engines under 1 litre, but has added horizontally opposed fours in the 1.0-1.5-litre class for its GS models. And the 2664-cc V-6 engine jointly developed by Peugeot, Renault, and Volvo is used by Peugeot in its 504 and 604 cars and by Renault in its R30 TS.

West Germany – BMW, which used inline four-cylinder engines in all models except the 3200 CS (3168-cc V-8) in 1967 now uses two inline fours (1573 and 1766 cc) and six inline sixes with displacements ranging from 1990 to 3210 cc in various models. Although Mercedes-Benz continues to use inline fours and sixes (1988 to 2746 cc) on its 200 to 280 models, five V-8's (3499 to 6834 cc) now power 350 to 600 models. And, in 1974, Mercedes-Benz began producing a five-cylinder inline diesel engine (3005 cc) for the 300 D. Ford, which powered its cars with V-4 and V-6 engines in 1967, has gradually reverted to inline fours for all engines under two litres except for the 1700-cc V-6 used in the Granada 1.7. Ford engines above two litres are of V-6 design. Opel, which used inline fours below two litres and inline sixes for larger engines in 1967, now uses only inline fours (993 to 2068 cc) and a 2784-cc inline six for the Commodore GS/E. Audi continues to use inline fours, but has joined Mercedes-Benz in adding a five-cylinder inline – a 2144-cc fuel-injected gasoline engine for the 100 and 100 Avant. Except for the 1303, Volkswagen has converted from the air-cooled horizontally opposed fours of 1967 to water-cooled inline fours. And Porsche, which used horizontally opposed engines – a four and a six – in 1967, has dropped the four in favor of an inline four and added a V-8 for the 928.

Great Britain – In the British Leyland complex, the Austin-Morris cars use inline four-cylinder engines as in 1967, but the larger models powered by inline sixes have been dropped. Inline sixes and V-8's continue to be used on Rover, Daimler and Jaguar models, with a V-12 used on some Daimler, Jaguar, and Vanden Plas models. Ford, which had heavily adopted V-4 and V-6 engines in the mid-1960's, gradually phased out the V-4's with the last one disappearing in 1974. Today, most Fords are powered by inline fours, with V-6 engines used for 2.3 to 3.0 litres. Vauxhall is now totally inline four following discontinuance of the inline six Ventura. Rolls-Royce and Bentley continue to use V-8's.

Italy – Since 1967, Alfa Romeo, which predominantly used inline four-cylinder engines, has dropped its inline six and added a horizontally opposed four for the Alfasud in 1972. Fiat, which had used a 499-cc inline two for the 500 and Autobianchina Bianchina and inline fours and sixes for the remainder of the line in 1967, now uses a larger (652 cc) inline two for the Fiat 126 introduced in 1972 and inline fours for all other models. In addition to continuing the V-12, Ferrari has added a V-8 and a horizontally opposed 12 to its line. Lancia, which used two V-4's, two V-6's, and two horizontally opposed fours in 1967, has changed over to inline fours for its Beta models (which supplanted the Fulvia and Flaminia), two horizontally opposed fours in the new Gamma models, and a transversely mounted V-8 in the mid-engine Stratos.

Japan – Although inline fours power most Japanese models, mini cars with engines under 1 litre use either an inline twin (Daihatsu Kogyo Max Cuore, Fuji Subaru Rex 550, Mitsubishi Minica, Suzuki Fronte) or a three-cylinder inline (Daihatsu Kogyo Charade, Suzuki Fronte). Inline sixes are used by Nissan and Toyota for gasoline engines above two litres, and Nissan and Toyota also install V-8 engines in their largest cars (the 4414-cc Nissan President and 3376-cc Toyota Century).

United States – As shown in Figure 5, the V-8 engine continues to be the dominant engine type

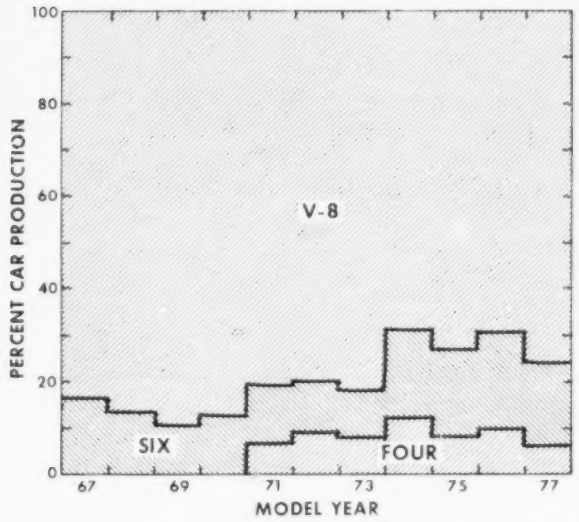

Figure 5. Trends in Engine Type in U.S. Cars.

in the U.S. After increasing its share of the U.S. market from 83.6% in 1967 to 89.0% in 1969, the V-8 share dwindled to 68.6% in 1974 with the growing popularity of small cars (by U.S. standards) powered by inline fours and sixes. During the 1969-74 period, the production share for these engine types rose from 0 to 12.7% for inline fours (Chevrolet Vega, Ford Pinto and Mustang II) and from 11.0% to 18.7% for sixes. Ford brought out a 2799-cc V-6 in 1974 for its Pinto and Mustang II. GM followed in 1975 with a 3785-cc V-6 for its Buick Skyhawk, Skylark, and Century and Oldsmobile Starfire, and later extended its use to other Buick, Oldsmobile, and Pontiac models. Since 1974, the V-8 share has increased to 75.8% in 1977, with the shares for the other types decreasing to 6.3% for inline fours and 17.9% for sixes (12.0% for inline sixes and 5.9% for V-6's). However, the share for V-8's will decline in the future due to the downsizing of cars, the development of new six-cylinder and four-cylinder engines, and the broadened application of these engines as standard equipment. For the first half of the 1978 model year, the V-8 share had already dropped to 67.2%, with the six-cylinder share climbing to 23.4%.

Other Engine Types – Two other engine types – the diesel and the rotary – compete with the traditional Otto-cycle engine. These will be discussed later under Competitive Engines.

Valve Location and Drive

Engine designers throughout the world agree unanimously on one subject – the valves in four-cycle engines should be in the cylinder head. However, designers differ on how the valves should be operated. A decade ago, most major car manufacturers (except for BMW, Mercedes-Benz, NSU, and Opel in West Germany, Alfa Romeo in Italy, and Honda in Japan) used side-mounted camshafts on inline engines or a single camshaft in the Vee of V-8 engines to drive pushrods and rocker arms on all or nearly all of their car models. Since then, however, the overhead camshaft has gained significantly in popularity, partly due to the development of the toothed belt to drive the camshaft. Less costly than chain drives, this steel-reinforced rubber belt also does not require the complicated tensioners used with chain drives.

France – In 1967, the valves of all four-cycle engines except for the new Peugeot 204 were operated by pushrods. Since then, Peugeot has adopted overhead camshafts for the engines used on its front-wheel-drive 104 and 304 models and the new V-6 (1974) used in its 504 Coupé and 604 cars. Chrysler also adopted overhead camshafts on the 1812-cc and 1981-cc engines used in the Chrysler 1610 and Chrysler 2L. Citroen uses overhead camshafts on the engines powering the GS models. Renault stayed with pushrods until it introduced its R30 TS in 1975 with the Peugeot-Renault-Volvo V-6 engine. And last fall Renault introduced a 1995-cc inline four with overhead camshaft in its new 20 TS.

West Germany – Overhead camshafts were well established in West Germany in 1967, being used on all BMW models except the 3200 CS, all Mercedes-Benz models, all NSU inline engines, one of the two Porsche engines, and the Opel Rekord inline fours. Today, Mercedes-Benz continues its tradition, BMW and Porsche are 100% overhead camshaft, Audi has converted completely from pushrods to overhead camshafts, and Volkswagen has changed from pushrods to overhead camshafts except for the 1303 engine. Ford continues to use pushrods on most models, exceptions being overhead camshafts on the 1294-cc Taunus 1300, 1593-cc Taunus-Capri II,

and 1993-cc Taunus-Escort RS. Opel uses overhead camshafts for the 1.2-litre to 1.9-litre engines powering Ascona, City, Manta, and Rekord models and the 2.8-litre inline six for the Commodore GS/E.

Great Britain – In 1967, overhead camshafts in Great Britain were largely reserved for high-performance or status cars, with twin overhead camshafts used by Aston Martin, Daimler, Jaguar, and Ford's Cortina Lotus and a single overhead camshaft used for the Rover 2000. An exception was the overhead-camshaft 875-cc engine used by Rootes (later Chrysler) in the Hillman and Sunbeam Imps and Singer Chamois. Although the Sunbeam (front engine-rear drive successor to the rear engine-rear drive Imps) is the only Chrysler model with an overhead-camshaft engine, other car manufacturers have added overhead-camshaft engines in the last decade. Ford has paralleled Ford in West Germany by adopting overhead-camshaft engines of 1593 and 1993 cc for its Capri II and Cortina models as well as a twin overhead camshaft for its Escort RS 1800. Vauxhall has split its mix, with pushrods for its 1256 and 1584 cc engines and overhead camshafts for its 1759 cc and larger engines. British Leyland employs overhead-camshaft engines of 1485 and 1748 cc for its Austin Allegro and Maxi models and of 1854 to 5343 cc for Triumph, Princess, Rover, Daimler, and Jaguar models.

Japan – In 1967, overhead camshafts in Japan were limited to the three under one-litre engines used by Honda, the three six-cylinder engines (1988-2494 cc) used by Nissan for Prince and Cedric models, the 985-cc and 1490-cc engines in Toyo Kogyo's new Mazda 1000 and 1500 (predecessors of today's Familia), and the 1988-cc six in Toyota's Crown Super Deluxe. Since then, Japanese designers have paralleled West Germany in their adoption of the overhead camshaft. Daihatsu Kogyo and Fuji (Subaru) use overhead camshafts for the inline twins in the Max Cuore and Rex 550. Honda, Isuzu, Mitsubishi, Suzuki, and Toyo Kogyo have gone 100% for overhead camshafts in their gasoline four-cycle engines. Nissan uses overhead camshafts in all gasoline engines of 1595 cc or larger except for the V-8 used in the President. Toyota uses overhead camshafts – single or twin – for most engines above 1588 cc.

United States – In the United States, pushrod-operated valves are used on essentially all engines. Exceptions using overhead camshafts are the 1714-cc four for the year-old Plymouth Horizon and Dodge Omni, the 2294-cc four for Ford Fairmont, Mustang II, and Pinto and Mercury Bobcat and Zephyr, and the 1599-cc four for the Chevrolet Chevette.

Other Countries – In Sweden, Saab and Volvo use overhead camshafts for all engines except the 1498-cc four in Saab 95 and 96 models and the 1986-cc four in Volvo 242, 244, and 245 models. Brazil now has six overhead-camshaft engines – a twin-camshaft 2310-cc four for the Alfa Romeo 2300 and single camshafts for the 1049-cc Fiat 147L, 2301-cc Ford Maverick, 1398-cc Chevrolet Chevette, and 1471-cc and 1588-cc Volkswagen Passat. Spain has overhead camshafts only in some Seat models patterned after Fiat models. A similar situation exists in Russia where overhead-camshaft engines power the Fiat-based Zhiguli (Lada) models. In addition, a 1479-cc overhead-camshaft four is used in the Moskvich 2137 and 2140 cars. In Eastern Europe, overhead-camshaft engines are used in Czechoslovakia's Tatra T 613 (3495-cc V-8) and Yugoslavia's Zastava 101 (1116-cc four).

Engine Capacity

The trends in percentages of total car production for various ranges of engine capacity from 1967 to 1977 are shown in Figure 6 for France, Great Britain, and West Germany and Figure 7 for Italy, Japan, and the United States.

France – In France, the production share for engines larger than 1.5 litres has remained nearly constant during the last decade, varying from 17% to 23%. However, the share for engines of 1.0-1.5 litres rose from 37% in 1967 to 48% in 1971 at the expense of engines of less than 1 litre, whose share dropped from 46% to 29% during that period. The change occurred because three of the four major manufacturers added models powered by 1.0-1.5 litre engines while leaving the under-1-litre range essentially unchanged. Peugeot added the 1288-cc 304 in 1969. Renault added the 1289-cc R12 in 1969 and the 1108-cc R6 TL and 1289-cc R15 TL in 1971, and Simca (later

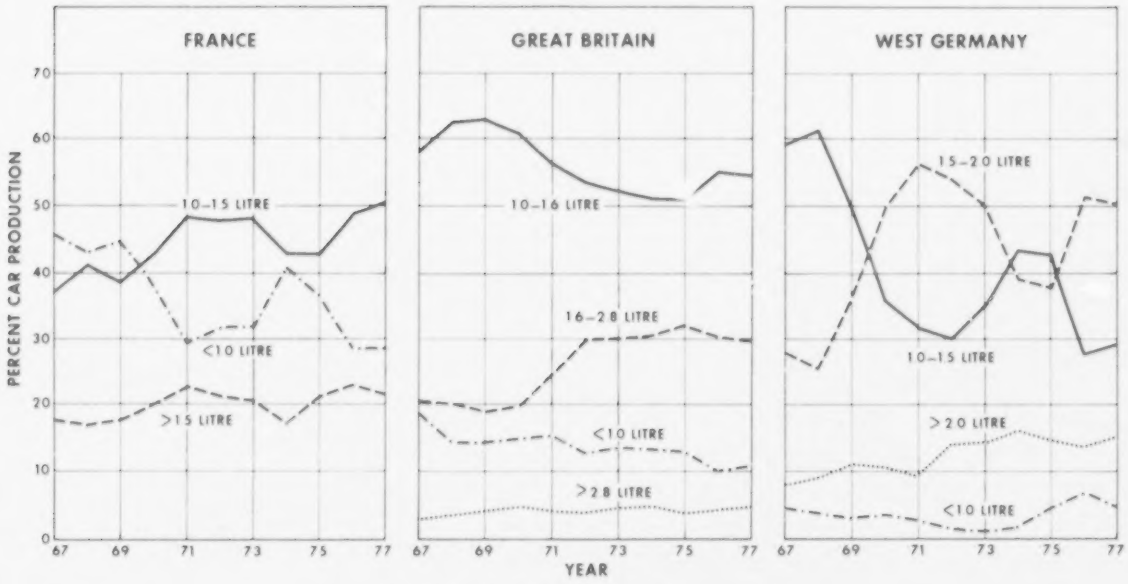

Figure 6. Trends in Car Engine Capacity

Chrysler) brought out the 1118-cc 1100 and 1204-cc 1200S in 1967. Later, in 1972, Citroen produced its first car in the 1.0-1.5 litre class – the 1015-cc GS – and followed a year later with the 1222-cc GS 1220. The rising share of production for 1.0-1.5 litre cars was checked in 1972 by two new models in the under-1-litre class – the Renault 5 models powered by 782-cc and 956-cc engines and Peugeot's 954-cc 104 (Peugeot's first entry under 1 litre). The drop in production share for 1.0-1.5 litre cars in 1974 to 42% and the rise of the under-1-litre share to 41% can be traced to these cars plus the aftereffects of 1973's energy shortage, which boosted production of almost all French cars under 1 litre. Since 1974, the production share for 1.0-1.5 litre cars has rebounded to a new high of 50% in 1977, accompanied by a decline in the under-1-litre share to 28%. This largely resulted from Simca's bringing out the 1307 (1294 cc) and 1308 (1442 cc), Renault's addition of 1289-cc and 1397-cc engines for the R5 line, and Renault's introduction of the 1218-cc R14.

Great Britain – In Great Britain, the production share for engines over 2.8 litres has shown little change in the last decade, ranging from 3 to 5%. At the same time, the share for engines at the other extreme (less than 1 litre) has dropped from 19% in 1967 to 10% in 1976, largely because of Ford's dropping the Anglia and the reduced number of under-1-litre models offered by British Leyland and Chrysler (e.g., the Riley Elf, Wolseley Hornet, and Hillman Imp are no longer made). However, addition of the Ford Fiesta late in 1976 raised the under-1-litre share to 11% in 1977.

The decline in production share for the 1.0-1.6 litre engines from 63% in 1969 to 51% in 1974 was accompanied by a share increase from 19% in 1969 to 30% in 1974 for engines of 1.6-2.8 litres. This shift largely resulted from new models in the 1.6-2.8 litre class, notably the 1748-cc Austin Allegro and Maxi, the 1601-cc Ford Escort, and the 1798-cc Morris Marina. The subsequent slight gain in production share for the 1.0-1.6 litre engines to 55% in 1977 largely stemmed from the 1798-cc and 2227-cc Princess of British Leyland and Vauxhall's 1256-cc Chevette.

West Germany – In West Germany, the cylinder capacity trends have largely resulted from the introduction of new models and the phasing out of old models. For engines of 1.0-1.5 litres, the sharp drop in production share from 61% in 1968 to 30% in 1972 largely resulted from Volkswagen's phasing out of the 1493-cc 1500 in favor of the 1584-cc 1600 (with the 1500 dropped

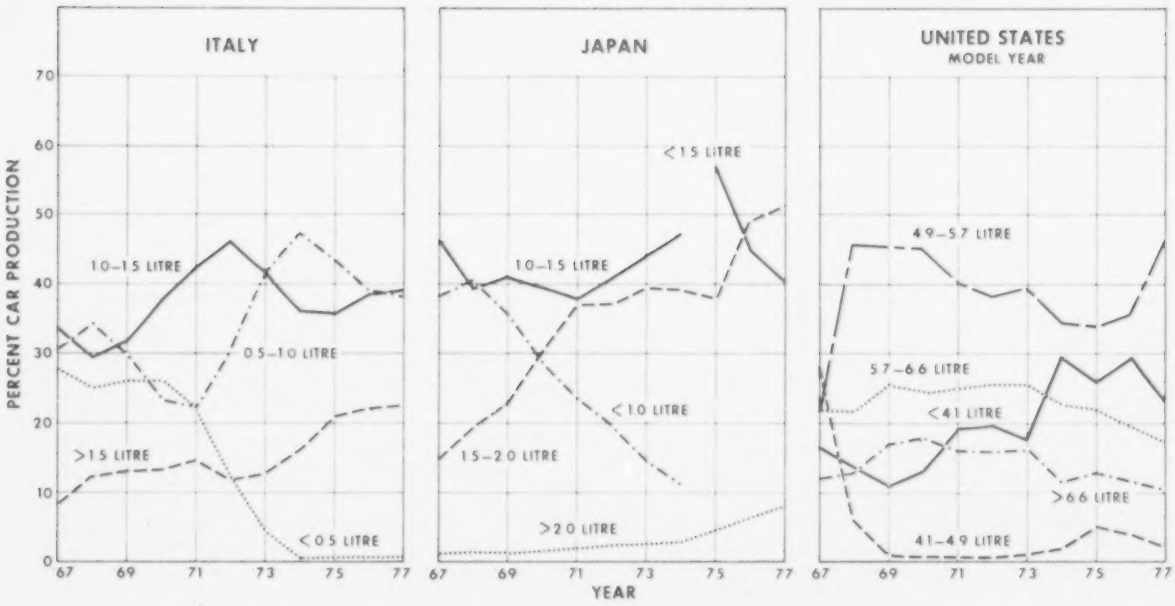

Figure 7. Trends in Car Engine Capacity

from the line in 1970) and, to a lesser degree, decreasing production of the Opel Kadett. Then, the rise in the 1.0-1.5 litre share of production to 43% in 1974 stemmed from such new models as the 1297-cc VW Passat (1973), the 1470-cc VW Passat (1973), and the VW Golf and Audi 80 (1974). The subsequent drop in production share to 28% in 1976 occurred because production of the 1470-cc VW Golf and Passat dropped severely when VW brought out the 1588-cc engine for these models in 1975.

For 1.5-2.0 litre engines, the share rise from 28% in 1968 to 56% in 1971 resulted from the previously mentioned VW 1600, which was introduced in 1969, and, to a lesser degree, the 1749-cc Audi 100 (1969), 1584-cc and 1897-cc Opel Ascona and Manta (1970), and 1993-cc Ford Capri 2000 (1971). The subsequent share drop to 38% in 1975 occurred due to increased competition from the new engines in the 1.0-1.5 litre range, a drop in production of the 1584-cc and 1897-cc Opel Ascona and Manta models, and increased competition from new engines above 2 litres, such as the Mercedes-Benz 240 (1973) and Ford's Consul and Granada models in 1972, with their 2293-cc, 2551-cc, and 2994-cc engines (the latter also account for the share rise for engines greater than 2.0 litres from 9% in 1971 to 16% in 1974). The sharp increase in production share for the 1.5-2.0 litre engines from 38% in 1975 to 51% in 1976 stems from the previously noted addition of the 1588-cc engine for the VW Golf and Passat along with the new VW Scirocco.

Italy – With Fiat the dominant car-producing company in Italy, it is not surprising that the trends in engine capacity reflect the Fiat model line. For example, the drop in production share for car engines less than 0.5 litre from 26% in 1970 to less than 1% in 1974 initially reflected the competition of new Fiat models in the 0.5-1.0 and 1-1.5 litre ranges, followed by a large drop in 1972 when Fiat increased the displacement of the 500 from 499.5 cc to 594 cc by adding 6.1 mm to the stroke. This change, in turn, helped boost the 0.5-1.0 litre share from 22% in 1971 to 47% in 1974. Other strong contributors to the share rise for 0.5-1.0 litre engines were the introduction of Fiat's 903-cc 127 models in 1971 and 1972 and the 594-cc 126 in 1973 and Alfa Romeo's 1186-cc Alfasud in 1972. The drop for 1.0-1.5 litres to 36% in 1974 probably resulted from a combination of competition from the new Fiat and Alfa Romeo 0.5-1.0 litre models and the effects of the 1973 energy crisis. The decline in production share for the 0.5-1.0 litre range from 47% in 1974 to 38% in 1977 primarily stemmed from Fiat's discontinuing the 500 in 1975 and offering a 1049-cc engine on the 127.

The production share for engines larger than 1.5 litre ranged from 9% to 14% during the 1967-73 period. Since then, the share has risen from 12% in 1973 to 22% in 1977, largely due to the 1585-cc Fiat 131 introduced in 1974.

Japan – Prior to 1958, most cars in Japan were either publicly owned, business owned, or used as taxicabs. However, Japan's rapidly expanding economy was producing a growing segment of potential private buyers. Initially, Japanese car manufacturers tapped this market by producing short wheelbase "light type" cars powered by engines of less than 361-cc capacity (the taxation structure also favored these cars). As a result, the production share for cars with engines less than 361-cc capacity rose from 1% in 1958 to 23% in 1968. With cars in the 361-1000 cc range taking 17% of the production share, the share for cars under 1 litre reached a high of 40% in 1968.

In the meantime, however, the flourishing Japanese economy was creating a private market for cars with larger engine capacity. In addition, Japan's aggressive expansion into the world market required cars and engines that would meet the buyer's desire in this market, particularly Japan's best customer – the United States. As a result, the production share for engines under 1 litre dropped to 11% in 1974, with engines under 361 cc claiming only 3% of car production. For the revised taxation system of 1976, which provides a tax break at 550 cc instead of 360 cc, the share for engines less than 551 cc remained at 3% for 1977. (The discontinuous curves in Figure 7 result from Japan's changing its reporting system starting with the 1975 models.)

As a result of the changing domestic market and increasing export share of production (54% in 1977), the production share for engines less than 1.5 litre has declined from 85% in 1967 to 41% in 1977. During the same period, the share for 1.5-2.0 litre engines has increased from 14% to 51%, while the share for engines larger than 2.0 litres has increased from 1% to 8%.

United States – Three curves – less than 4.1 litres, 4.1-4.9 litres, and 4.9-5.7 litres – in the U.S. trend set are of particular interest. The sharp rise of production share for the 4.9-5.7 litre engines from 21% in 1967 to 46% in 1968 and the accompanying decrease for 4.1-4.9 litre engines from 29% in 1967 to 6% in 1968 reflect changes by Chrysler, Ford Motor, and General Motors in their V-8 engines. Chrysler, which had used 4474-cc and 5211-cc V-8's in 1967 Plymouth and Dodge models, expanded use of the 5211-cc engine in 1968. Ford Motor, which had used a 4736-cc V-8 in 1967 Ford and Mercury models, adopted a new 4949-cc V-8 for Mercury models and offered both engines on Ford models in 1968. And General Motors, which had used 4638-cc and 5359-cc V-8's in 1967 Chevrolets, dropped the 4638-cc engine in 1968 in favor of a 5031-cc V-8 – a smaller-bore version of the 5359-cc V-8. The 4.9-5.7 litre share declined from 46% in 1968 to 34% in 1975, largely because of the introduction of domestic subcompacts (e.g., Chevrolet Vega and Ford Pinto) with their smaller (by U.S. standards) engines. However, the 4.9-5.7 litre share jumped from 36% in 1976 to 47% in 1977 because of four engines – GM's new 4932-cc V-8 and substantially increased use of GM's 4998-cc V-8 (up 245%), Ford's 4949-cc V-8 (up 64%), and Chrysler's 5211-cc V-8 (up 45%).

The third curve is the less-than-4.1 litre curve. Here, the growth in production share from 11% in 1969 to 30% in 1974 reflects the growing popularity of "compact" cars in the U.S. with their smaller engines. The share drop for under-4.1-litre engines in 1977 largely reflects the widespread use of the 4.9-litre and 5.0-litre V-8's in GM's 1977 models. As a result, the weighted-average engine capacity based on production remained essentially unchanged (5166 cc for 1977 vs. 5170 cc for 1976).

The share for under-4.1-litre engines should climb in the next few years with the development of fours and sixes (particularly V-6's) in this size range as standard equipment for downsized cars. Ford Motor recently predicted that the average sales-weighted engine size for Ford cars will drop from over 5 litres in 1977 to about 3 litres in 1983, partly due to a new lightweight V-6 and new 1.3-litre and 1.6-litre fours.

Figure 8, which shows the 1977 production shares of various engine capacities for cars,

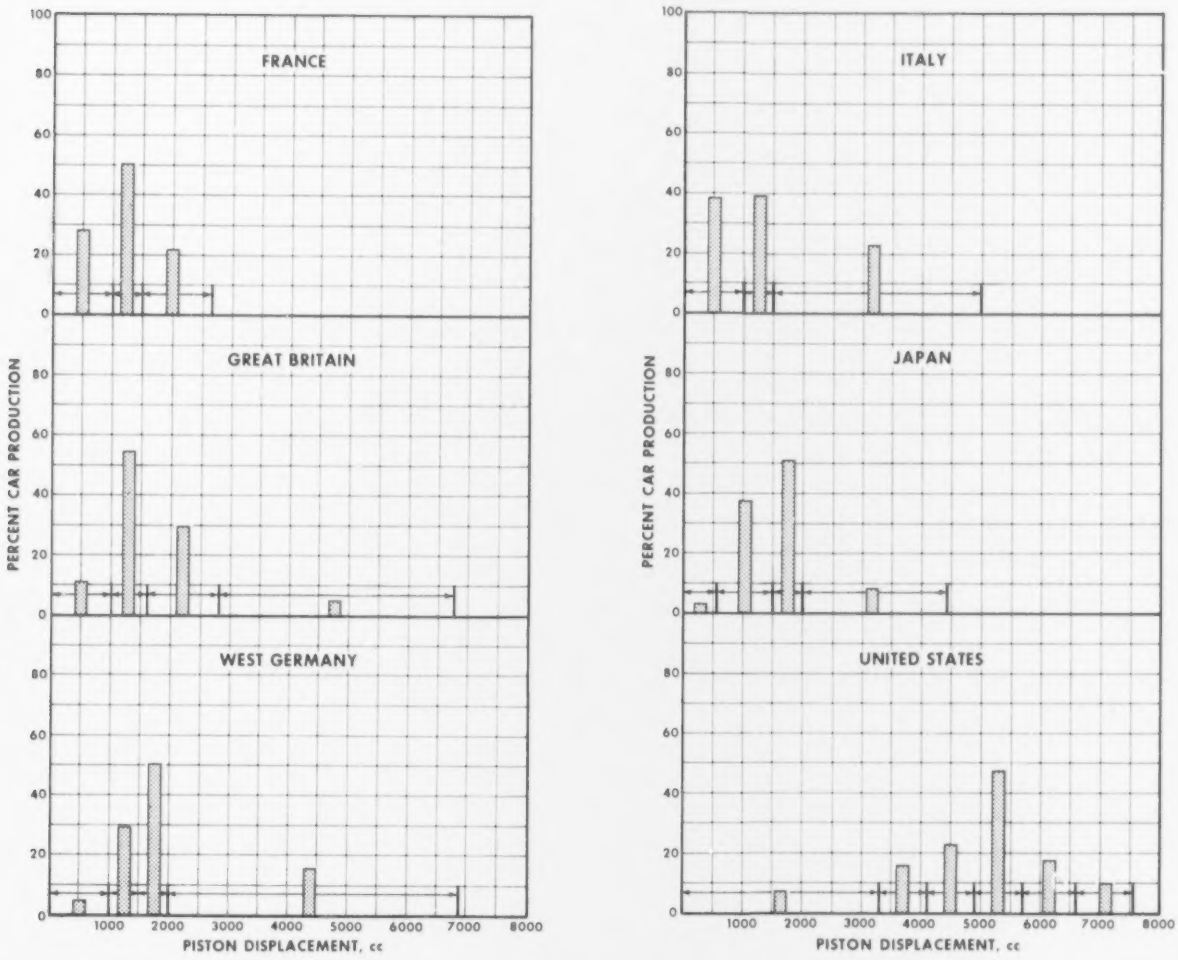

Figure 8. Production Distribution of Car Engine Capacity in 1977

graphically compares today's capacity philosophies of the six countries. As shown, engines of 1.0-1.5 litres took the largest share in France (50%). A similar situation exists in Great Britain where 1.0-1.6 litre engines powered 55% of car production. However, the two countries differ in that the production share for engines under 1.0 litre was 28% in France and only 11% in Great Britain. The production mix in West Germany and Japan is almost identical. Engines of 1.5-2.0 litres took the largest share (50% in West Germany and 51% in Japan) and engines less than 1.5 litre in size were used in 34% of West Germany's car production and 37% of Japan's. In Italy, 1.0-1.5 litre engines took the largest share (39%) in 1977, closely followed by under-1-litre engines with 38%. In the United States, the dominant engine group was the 4.9-5.7 litre range of V-8 engines with 47%.

Competitive Engines

At present, the only in-production competitors to the conventional Otto-cycle and two-cycle gasoline engines as powerplants for passenger cars are rotary and diesel engines. Other engines – gas turbine, steam, Stirling, etc. – and the electric car have been proposed and are currently involved in research and development programs, but none show signs of evolving into practical mass-produced car powerplants in the near future.

Rotary Engines – The advent of emission standards spurred widespread interest in the Wankel rotary engine, partly because of its inherently low NO_x emissions compared to the four-cycle engine. However, General Motors, which had embarked on a large research and development program, has abandoned the rotary

engine because of high hydrocarbon emissions. And NSU, which had produced the first rotary engine production car (the Spider with a single-rotor, 50-hp, 500-cc engine) in 1964, discontinued production of its latest model (Ro-80) early in 1977.

Today, Toyo Kogyo in Japan is the only manufacturer of cars powered by rotary engines. Toyo Kogyo produced its first rotary engine car, the Mazda Cosmo Sport, in 1968 with a twin-rotor engine. Since then, the Toyo Kogyo rotaries have gone through a series of evolutionary changes resulting from active research and development. For 1978, Toyo Kogyo offers two twin-rotor engines powering various car models.

Diesel Engines – In 1967, only four car manufacturers produced diesel-powered cars – Mercedes-Benz (1988-cc 200 D) in West Germany, Peugeot (1816-cc 403 and 1948-cc 404) in France, British Motor (1489-cc option on Morris Oxford Series VI) in Great Britain, and Nissan (2164-cc Datsun) in Japan.

Although advocates of diesel engines for cars stressed the advantages of greater reliability, lower maintenance costs, better fuel economy, and fuel price differential, these were counterbalanced by the disadvantages of higher initial cost and problems of noise, odor, roughness, hard starting in cold weather, and inferior performance. As a result, interest in the development of diesel-powered cars was at a fairly low level.

However, times and conditions change. The gasoline shortage of the early 1970's and rising fuel prices have made fuel economy an even more important criterion in engine design and have triggered interest in the diesel engine throughout the world. The result has been an increasing number of diesel-powered cars in recent years. Table 2 lists the diesel-powered passenger cars in current production. Most have been introduced in the past two years, with some(e.g., Alfa Romeo's Alfetta, Fiat's 131 and 132, and Volkswagen's Passat) entering production in the last few months. At Mercedes-Benz, which expanded its line from the 1988-cc 200 D in 1967 to models ranging from the 200 D to the turbocharged 3005-cc 300 SD, diesel engines now power almost half of Mercedes' car output. And one out of every six Golf's produced by Volkswagen in 1977 had a diesel engine. As a result, almost half a million (482,500) diesel-powered cars were built in Europe in 1977, led by West Germany (279,500) and France (167,400).

Moreover, the number of diesel-powered cars is sure to grow. Volvo in Sweden has announced the GL D-6, which will enter production early in 1979 with a 2.4-litre six built by Volkswagen. In the United States, General Motors introduced a 5.7-litre diesel for Oldsmobile and (in mid-year) Cadillac 1978 models and is adding a 4.3-litre V-8 for 1979 Oldsmobile models. GM reportedly will offer a 5.0-litre V-8 in Chevrolets in 1981 and a 3.8-litre V-6 in Buicks in 1982. In Great Britain, British Leyland has been working on a diesel engine that may be offered as an option on the front-wheel-drive Princess in 1980. Toyo Kogyo and Mazda are developing diesel car engines in Japan. In West Germany, VW has previewed a 2-litre version of the Audi 100 five-cylinder diesel to be used in some 1979 Audis. And BMW is planning a diesel car in 1982, using a Steyr-Daimler-Puch engine. Although no plans have been announced, Renault could come out with a diesel car since the Sofim plant in Italy that builds the diesel engines for the Fiat 131 and 132 is a joint venture by Fiat, Renault, and Alfa Romeo.

One obstacle faced by diesel engines is government-decreed limitations on NO_X emissions in Japan and the United States. If future stringent standards are maintained, diesel engine manufacturers may have to resort to exhaust gas recirculation (EGR) to meet these standards. As manufacturers point out, however, EGR causes increased particulate emissions, another area of concern for diesels. Another recent concern is the possible health hazards of diesel emissions.

Direct fuel injection into the combustion chamber is the most efficient design. However, when considered for car use, such engines tend to be rough and noisy. Therefore, all diesel engines for cars use indirect injection in which the initial kernel of rich mixture is formed in a small auxiliary combustion chamber (prechamber) off the main combustion chamber. This type of injection also lowers exhaust emissions.

TABLE 2

Diesel-Powered Passenger Cars
(As of September 1, 1978)

Car Model	No. of Cylinders	Displacement, cc	Prechamber Type	Injection Pump
		France		
Citroen				
CX 2200	4IL	2175	Swirl	Distributor
CX 2500	4IL	2500	Swirl	Distributor
Peugeot				
304 GLD	4IL	1357	Swirl	Distributor
504 LD Berline	4IL	1948	Swirl	Distributor
504 LD Break	4IL	2112	Swirl	Distributor
504 GLD	4IL	2304	Swirl	Distributor
		West Germany		
Mercedes-Benz				
200 D	4IL	1988	Jet	In-Line
220 D	4IL	2197	Jet	In-Line
240 D	4IL	2404	Jet	In-Line
300 D	5IL	3005	Jet	In-Line
300 SD (Turbocharged)	5IL	3005	Jet	In-Line
Opel				
Rekord 2.1 D	4IL	2068	Swirl	Distributor
Volkswagen				
Golf, Passat	4IL	1471	Swirl	Distributor
		Great Britain		
Ford				
Granada 2100 (Peugeot)	4IL	2112	Swirl	Distributor
		Italy		
Alfa Romeo				
Alfetta (Turbocharged)	4IL	2-Litre	Swirl	Distributor
Giulia	4IL	1760	Swirl	Distributor
Fiat				
131, 132	4IL	1995	Swirl	Distributor
132	4IL	2445	Swirl	Distributor
		Japan		
Isuzu				
Florian SII	4IL	1951	Swirl	Distributor
Nissan				
Gloria (Cedric)	4IL	1991	Swirl	In-Line
Gloria (Cedric)	4IL	2164	Swirl	In-Line
Toyota				
Crown 2200	4IL	2188	Swirl	Distributor
		Spain		
Seat				
132 Diesel	4IL	1988	Jet	In-Line
		United States		
General Motors				
Cadillac Seville, Oldsmobile Delta 88, Oldsmobile 98	8V	5735	Swirl	Distributor

Mercedes-Benz uses a jet-tvpe prechamber in which the injector spray impinges on a bulge that gets very hot when the engine warms up, promoting vaporization and mixing of the fuel. The prechamber is connected to the main chamber by a series of small holes, and piston action creates turbulence. However, most diesel engines for cars use a swirl prechamber in which a throat tangential to the prechamber links it to the main chamber. Upward movement of the piston during compression imparts a swirling motion to the air inside the prechamber, promoting mixing of the injected fuel and air.

Manufacturers of diesel engines for cars also have widely adopted the distributor-type injection pump in preference to the older in-line injection pump. Simpler and cheaper to produce, the distributor-type pump uses a single rotating and reciprocating plunger and cylinder for the engine in place of a plunger-cylinder combination for each cylinder.

Factors Affecting Engine Design

Engine and car design during the past decade has been largely affected by:

1. Government standards controlling exhaust emissions, particularly in Japan and the United States, and
2. More recently, stress on fuel economy resulting from the need to conserve petroleum, higher gasoline prices, and, in the U.S., government-mandated fuel economy standards.

Emission Control – The design approaches that have been used to meet emission standards basically fall into three categories:

1. Reduction of emissions from the engine through modifications in carburetion (or fuel injection), spark timing, and other engine design elements.
2. Reduction of emissions after they leave the engine, notably by using a thermal reactor or an oxidation catalyst and secondary air injection to lower hydrocarbon (HC) and carbon monoxide (CO) emissions and, more recently in the U.S. and Japan, three-way catalysts for lowering HC, CO, and NO_X emissions simultaneously.
3. Development of new engine designs.

Because exhaust hydrocarbon emissions result basically from a flame-quenching action, small but important changes have been made to minimize flame quenching. Potential quench pockets have been eliminated by modifying pistons, cylinder heads, and gaskets. Additional reductions of both HC and CO emissions have been realized by a variety of ways, including air injection into the exhaust ports, retarded spark timing, larger throttle opening during decelerations, and modifications of the carburetor and intake system. When the greatest control of HC and CO is required, it is necessary to turn to the add-on devices previously mentioned – the thermal reactor or catalytic converter. Thermal reactors are basically enlarged and insulated exhaust manifolds that provide a higher temperature and longer residence time in the exhaust system, thereby lowering HC and CO emissions by promoting oxidation. Thermal reactors have an advantage over catalysts because they are compatible with lead antiknocks and therefore the energy-extending attributes of the lead compounds can be used. Catalysts are placed in the exhaust system to aid in the oxidation of HC and CO and/or the reduction of NO_X. These can be highly effective, but they are expensive and the noble metal catalysts used commercially to date require unleaded gasoline. Most countries would like to avoid the use of unleaded gasoline because of the added expense of producing it as well as the waste of crude oil incurred in order to make gasoline of the required octane level by refining techniques alone.

In the United States, car manufacturers use a combination of a catalytic converter, secondary air injection, and exhaust gas recirculation (EGR) to meet the severe U.S. emission standards, with Chrysler producing some lean-burn engines in combination with a catalytic converter and EGR. Some of the imported car manufacturers also use catalysts, air injection and EGR, particularly in California. However, others have met the emission standards by using non-catalytic approaches, including engine modification, air injection, and, in some instances, thermal reactors. These cars have retained the ability to burn leaded gasoline.

One system that is highly effective in emissions reduction and is compatible with leaded gasoline is the "lean burn" system. This technique implies the use of air-fuel ratios leaner than stoichiometric and may be applied to either prechamber engines or open-chamber engines.

Ethyl Corporation has worked for many years on lean-mixture techniques. The latest developments from this work are based on an intake manifold design called the Turbulent Flow Manifold (TFM). This manifold incorporates methods for improved air-fuel mixing that create improved mixture quality plus better distribution of the mixture to the cylinders. This allows mixture ratios to be made leaner for significantly reduced emissions and lower fuel consumption without causing a loss in good driveability. The TFM is combined with a standard production carburetor (with minor adjustments or modifications) and ignition timing alterations to form the basic Turbulent Flow System (TFS). This simple system offers emission reduction and good fuel economy at low cost. When additional emissions reduction is desired, other devices can be added. These include exhaust port liners and thermal reactors (to increase the reaction of hydrocarbons and carbon monoxide in the exhaust system) and exhaust gas recirculation (to lower nitrogen oxide emissions). Finally, the most recent development in the TFM work is the Hybrid Reactor. This combines a programmed air injection system with the TFS, exhaust port liners, and thermal reactors to reduce HC and CO levels to extremely low levels. EGR may be added if needed. Although more expensive than the simple Turbulent Flow System, the TFM Hybrid Reactor offers an alternative to the catalytic converter when emissions must be reduced to the lowest levels.

Cooperative work on the various TFM systems is continuing with various automobile manufacturers around the world. The results of these various programs are reported periodically in technical papers.

One result of the use of catalysts in the U.S. has been a substantial lowering in compression ratio. Figure 9 shows the compression-ratio trend for U.S. cars from 1967 to 1977. From 1967 to 1970, the weighted-average compression ratio for cars in the U.S. based on model year ranged from 9.38:1 to 9.52:1. In 1971, compression ratios

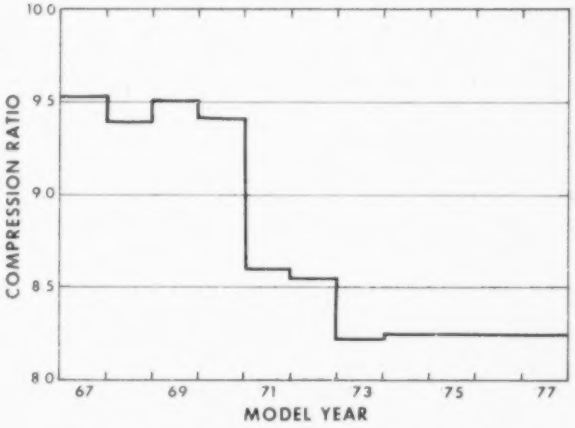

Figure 9. Trend in Compression Ratio of U.S. Cars
Weighted Average

were drastically reduced by U.S. car manufacturers to an average of 8.59:1 in anticipation of lower-octane unleaded gasoline for use in catalytic converters.* Since then, the average compression ratio has dropped to its present level of 8.25:1.

The U.S. trend to lower compression ratios has not been followed in Europe and Japan. Most engines in France, West Germany, Great Britain, and Japan have compression ratios in the range of 8.5:1 to 9.5:1, with some exceeding 9.5:1. Most engines in Italy have compression ratios above 9.0:1.

In Japan, which joins the U.S. in having the most severe emission standards in the world, Japanese car manufacturers have differed in their approach to controlling exhaust emissions. The various approaches include the Honda CVCC stratified-charge engines, lean-burn engines, and combinations of engine modifications and catalytic converters, including three-way catalysts with oxygen sensors and feedback fuel control systems.

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*Catalytic converters currently used require unleaded gasoline. If lead antiknocks are removed and no attempt is made to recover the lost octane numbers by refinery processing, the octane requirement of engines must be lowered by reducing the compression ratio and/or retarding the ignition timing, with a resulting loss in engine efficiency (fuel economy). On the other hand, recovery of the octane numbers lost due to antiknock removal requires additional processing equipment and more-severe processing, with a resulting loss of crude oil in the refinery. This is why antiknocks are called energy extenders.

Two other trends resulting directly from the need to control emissions have been (1) electronic ignition systems to provide more dependable ignition and (2) fuel injection.

Although fuel injection has been used for many years by Mercedes-Benz in West Germany, only a few other cars (e.g., Maserati 3500 GT, Peugeot KF2, and Lanica Flavia 1.8) employed fuel injection in the 1960's, primarily because of its relatively high cost and complexity. However, the need for uniform fuel-air mixtures in an engine's cylinders to permit more precise control of air-fuel ratio in order to reduce emissions spurred the development of mechanical and electronic fuel injection systems. Today, a sizable number of gasoline-powered cars worldwide use fuel injection, including some models produced by Citroen and Peugeot in France; BMW, Mercedes-Benz, Opel, Porsche (all models), and Volkswagen in West Germany; Ford, Jaguar and Vanden Plas in Great Britain; Isuzu, Nissan, and Toyota in Japan; Saab and Volvo in Sweden; and GM's Cadillac in the U.S.

The most widely used fuel injection systems are the K-Jetronic and L-Jetronic produced by Bosch. The K-Jetronic is a mechanical system that provides continuous metered fuel injection into the intake ports. The variable fuel flow rate is controlled by a hinged plate in the intake manifold, where angular position is used to control the fuel flow in proportion to the air mass flow through the manifold.

The L-Jetronic system is an electronic system consisting of a pump, a solenoid-operated injection valve at each cylinder, and a control system whose primary elements are an electronic control unit (ECU) and a pressure sensor in the intake manifold. The pressure sensor converts intake manifold pressure to an electrical signal to the ECU. The ECU then shortens or lengthens the current pulse to each solenoid-operated injection valve, thereby determining the length of time that each valve is open and thus the amount of fuel injected. Secondary control is provided by signals fed to the ECU by a temperature sensor (to vary fuel quantity inversely with temperature) and by a signal from ignition distributor trigger contacts (to vary fuel injection with engine speed).

Fuel Economy – Improved fuel economy has been achieved through such means as better control of ignition over the speed-load range (e.g., electronic ignition), improved fuel control through improved carburetion or fuel injection, and lockup automatic transmissions in which the transmission and flywheel are mechanically locked together when the transmission shifts into high gear, thereby eliminating torque converter slip. In the U.S., government-mandated fuel economy standards that will become increasingly stringent have led car manufacturers to also resort to car weight reduction through (1) greater use of lighter materials (e.g., aluminum, plastics, high-strength low-alloy steels) and (2) reductions in car size. The result has often been a weight reduction of 800 to 1000 pounds from one model year to the next.

Working against the goal of improved fuel economy in the U.S. has been the previously noted decrease in compression ratio. This has been caused by the very stringent levels of emissions regulation, which led to the use of catalytic converters and thus unleaded gasoline. In some other countries, compression ratios may be low because the refining industry is new and growing and has not yet utilized the full potential of the energy-extending abilities of lead anti-knocks.

The relationships between fuel economy and compression ratio and between compression ratio and octane requirement have been the subjects of many investigations, including several by Ethyl Corporation. Using data from many of these, a simple relationship between fuel consumption and Research octane number has been calculated and is shown in Figure 10. Average fuel sensitivities for leaded gasolines were assumed. This relationship includes the further assumption that any change in compression ratio is accompanied by a driveline gear change that results in constant vehicle acceleration capability. The reason for this is that an increase in compression ratio permitted by the higher Research octane number brings about a direct increase in both fuel economy and

engine power.* By changing the transmission or axle gear ratio, the acceleration capability can be reduced to the original value by slowing the engine. Because the lower engine speed brings about both lower friction and less engine pumping loss, fuel consumption is further reduced.

As shown in Figure 10, the decrease in fuel consumption as Research octane number (and thus compression ratio) is increased is dramatic. For example, raising the Research octane number from 85 RON to 90 RON would be expected to decrease fuel consumption by about 6.5%. When an octane gain such as this is made by using antiknocks, the fuel saving is achieved without the crude-oil loss that would be incurred if the octane numbers were obtained by refinery processing.

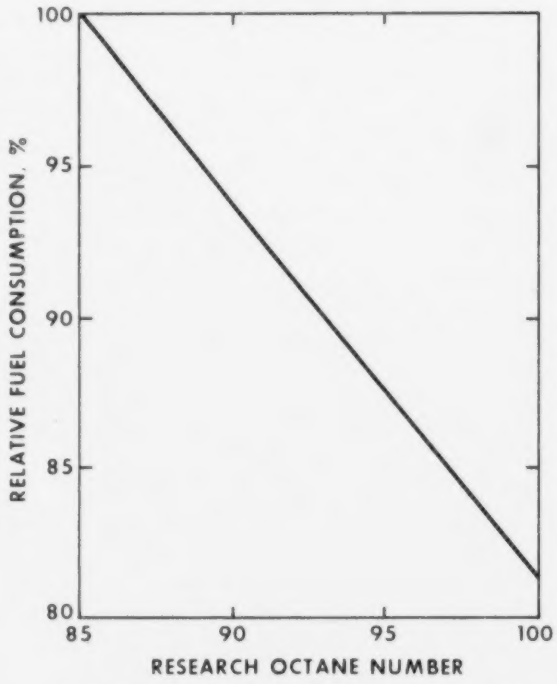

Figure 10. Effect of Octane Number on Vehicle Fuel Consumption
Assumes compression ratio is changed to accept available octane number and acceleration capability is held constant

*Octane number is a measure of the ability of a gasoline to resist knock in an engine. A higher octane number permits the engine manufacturer to raise the octane number requirement (ONR) of the engine by raising its compression ratio or, if the ignition timing has been retarded to lower ONR, advancing the ignition timing. Either step produces a more-efficient engine and thus lowers fuel consumption.

APPENDIX

The tables in this appendix, which list brief specifications of 1978 passenger-car engines, differ from the usual specification listing in that the list for each manufacturer in a country is arranged in order of increasing engine capacity, thereby showing the engines shared by various car lines and models produced by each manufacturer.

Although we have attempted to make these tables as accurate and complete as possible, we have no illusions that we will be the first to publish a totally accurate specifications list. One of the major problems occurs in the horsepower listing. The various methods of rating and reporting horsepower make it impossible to secure ratings that are directly comparable in all cases. We have attempted to list the net horsepower, usually by DIN in Europe and SAE net in the U.S., whenever possible, but have been forced to show gross horsepower for some models.

Another problem is that new models are introduced and old models are dropped throughout the year. Thus, we may omit some models that entered production during recent months.

Partly to keep the number of tables to a reasonable number, we have not listed the engines for cars in 3 of the 20 top car-producing nations in 1977 – Belgium, Canada, and Mexico. Belgium is an "assembly" country, with cars assembled from components supplied by various manufacturers from other countries (e.g., Ford, General Motors, Renault, and Volkswagen). Canada's cars are similar to those produced by U.S. companies – American Motors, Chrysler, Ford, and General Motors – and Volvo in Sweden. And Mexico's cars are based on models built by American Motors, Chrysler, Ford, General Motors, Nissan, and Volkswagen.

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
ARGENTINA												
Chrysler Fevre Argentina												
Dodge 1500	FR	4	4IL	OHV	86/64	1498	91.4	72G	5400	8.00	C	W
Dodge 1500 M 1.8	FR	4	4IL	OHV	86/77	1798	109.7	92G	4900	8.60	C	W
Dodge Coronado	FR	4	6IL	OHV	86/105	3687	225.0	145G	4400	8.40	C	W
Dodge GTX	FR	4	8V	OHV	99/84	5211	318.0	230G	4400	8.80	C	W
Fiat Concord												
600 S	RR	4	4IL	OHV	62/66	797	48.6	32	4800	7.40	C	W
600 R	RR	4	4IL	OHV	62/66	797	48.6	36G	5000	7.70	C	W
133	RR	4	4IL	OHV	65/68	903	55.1	40	5600	8.40	C	W
128	FF	4	4TR	OC	80/56	1116	68.1	63G	6000	8.80	C	W
128 L	FF	4	4TR	OC	86/56	1290	78.7	70G	6250	8.90	C	W
128 Familiar	FF											
1300 TV	FF	4	4TR	OC	86/56	1290	78.7	90G	6250	8.90	C	W
125	FR	4	4IL	TOC	80/80	1608	98.1	100	6200	8.80	C	W
Ford Motor Argentina												
Taunus L 2000	FR	4	4IL	OC	89/79	1990	121.4	92G	5500	8.00	C	W
Taunus GXL	FR											
Taunus GXL 2300	FR	4	4IL	OC	96/79	2299	140.3	122G	5000	9.00	C	W
Taunus GT 2300	FR											
GM Argentina												
Opel K-180	FR	4	4IL	OHV	90/70	1802	110.0	74	5200	8.20	C	W
Chevy Standard	FR	4	6IL	OHV	98/83	3769	230.0	126	4400	7.50	C	W
Chevy Super	FR											
Chevy Malibu	FR	4	6IL	OHV	98/90	4097	250.0	138	4400	8.10	C	W
Chevy Coupe Serie 2	FR	4	6IL	OHV	98/90	4097	250.0	150	4000	8.10	C	W
IKA-Renault												
Torino Grand Routier	FR	4	6IL	OC	85/111	3769	230.0	180G	4700	8.00	C	W
Torino TSX	FR	4	6IL	OC	85/111	3769	230.0	200G	4500	8.20	C	W
AUSTRALIA												
Chrysler Australia												
Centura	FR	4	6IL	OHV	96/93	4015	245.0	123G	4400	7.60	C	W
Valiant Sedan, Wagon	FR	4	6IL	OHV	96/93	4015	245.0	138G	4400	9.00	C	W
Valiant Regal Sedan	FR											
Valiant Charger 770	FR											
Valiant Sedan, Wagon (Opt.)	FR	4	6IL	OHV	99/93	4345	265.1	146G	4800	9.00	C	W
Valiant Regal Sedan (Opt.)	FR											
Valiant Charger 770 (Opt.)	FR											
Valiant Regal Wagon	FR	4	8V	OHV	99/84	5211	318.0	143G	4400	8.20	C	W
Valiant Regal SE	FR											

* FR–Front Engine Rear Drive, FF–Front Engine Front Drive, RR–Rear Engine Rear Drive, MR–Mid Engine Rear Drive

** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

†† G–Gross Rating

‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
AUSTRALIA (Cont'd.)												
Ford Motor Australia												
Escort L, GL	FR	4	4IL	OHV	81/78	1598	97.5	98G	6000	9.00	C	W
Cortina TE	FR	4	4IL	OC	90/77	1998	121.9	112G	6000	9.20	C	W
Escort Ghia	FR											
Cortina TE (Opt.)	FR											
Falcon	FR	4	6IL	OHV	94/79	3277	200.0	130G	4600	9.10	C	W
Falcon 500 Sedan	FR											
Cortina TE (Opt.)	FR											
Fairmont Sedan	FR	4	6IL	OHV	94/99	4097	250.0	155G	4000	9.10	C	W
Falcon 500 HT	FR											
Fairlane 500	FR											
Fairmont Coupe	FR	4	8V	OHV	102/76	4949	302.0	240G	5000	9.40	C	W
Fairmont Wagon	FR											
Fairmont GXL	FR											
Fairlane Marquis	FR	4	8V	OHV	102/89	5752	351.0	260G	4600	9.10	C	W
Falcon 500 (Opt.)	FR											
LTD	FR	4	8V	OHV	102/89	5752	351.0	290G	5000	11.00	C	W
General Motors-Holden's												
Gemini TC	FR	4	4IL	OC	82/75	1584	96.7	100	6000	8.70	C	W
Sunbird	FR	4	4IL	OC	93/70	1897	115.8	96G	5200	8.80	C	W
Torana LX 2850	FR	4	6IL	OHV	89/76	2834	173.0	105G	4000	9.40	C	W
HZ Kingswood	FR											
HZ Premier	FR	4	6IL	OHV	92/82	3298	201.2	110G	4000	9.40	C	W
Torana LX 3300	FR											
HZ GTS	FR	4	8V	OHV	92/78	4146	253.0	161G	4550	9.40	C	W
Torana LX 4150	FR	4	8V	OHV	92/78	4146	253.0	175G	4800	9.00	C	W
HZ Statesman	FR	4	8V	OHV	102/78	5047	308.0	216G	4800	9.70	C	W
Torana LX 5000	FR	4	8V	OHV	102/78	5047	308.0	250G	5000	9.70	C	W
BRAZIL												
Chrysler do Brasil												
Dodge Polara	FR	4	4IL	OHV	86/77	1798	109.7	85G	5000	7.70	C	W
Dodge Polaro Gran Luxo	FR											
Dodge Dart De Luxo	FR	4	8V	OHV	99/84	5211	318.0	198G	4400	7.50	C	W
Dodge Dart Gran	FR											
Dodge Charger R/T	FR	4	8V	OHV	99/84	5211	318.0	205G	4400	7.50	C	W
Fabrica Nacional de Motores												
Alfa Romeo 2300	FR	4	4IL	TOC	88/95	2310	141.0	140G	5700	7.50	C	W
Alfa Romeo 2300 B	FR	4	4IL	TOC	88/95	2310	141.0	141G	5700	7.50	C	W
Alfa Romeo 2300 TI	FR	4	4IL	TOC	88/95	2310	141.0	149G	5700	7.50	2C	W
Fiat Automoveis												
147L	FF	4	4TR	OC	76/58	1049	64.0	51	6000	7.20	C	W
Ford Brasil												
Corcel II	FF	4	4IL	OHV	75/77	1372	83.7	54	4600	8.00	C	W
Corcel II Belina	FF											
Corcel II GT	FF	4	4IL	OHV	75/77	1372	83.7	57	4800	8.00	C	W
Maverick	FR	4	4IL	OC	96/79	2301	140.4	99G	5400	7.80	C	W

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
BRAZIL (Cont'd.)												
Ford Brasil (Cont'd.)												
Maverick GT	FR	4	8V	OHV	102/76	4949	302.0	197G	4600	7.50	C	W
Galaxie 500	FR	4	8V	OHV	102/76	4949	302.0	199G	4600	7.70	C	W
Galaxie LTD	FR											
Galaxie Landau	FR											
GM do Brasil												
Chevrolet Chevette	FR	4	4IL	OC	82/66	1398	85.3	60	5400	7.80	C	W
Chevrolet Opala	FR	4	4IL	OHV	102/76	2474	151.0	80	4400	7.50	C	W
Chevrolet Opala SS-4	FR	4	4IL	OHV	102/76	2474	151.0	88	4600	7.50	C	W
Chevrolet Comodoro 4	FR											
Chevrolet Comodoro 6	FR	4	6IL	OHV	98/90	4097	250.0	127	3800	7.50	C	W
Chevrolet Opala SS-6	FR	4	6IL	OHV	98/90	4097	250.0	149	4600	7.80	C	W
Chevrolet Opala (Opt.)	FR	4	6IL	OHV	98/90	4097	250.0	153	4600	8.00	C	W
Chevrolet Comodoro 6 (Opt.)	FR											
Chevrolet Veraneio	FR	4	6IL	OHV	95/100	4277	261.0	151G	3800	7.80	C	W
Puma												
Mini	FF	4	2HO	OHV	83/69	760	46.4	30G	4500	7.60	C	A
GTE 1600	RR	4	4HO	OHV	86/69	1584	96.7	90G	5800	9.00	C	A
GTS 1600	RR											
Volkswagen do Brasil												
1300	RR	4	4HO	OHV	77/69	1285	78.4	38	4000	6.80	C	A
1300 L	RR											
Passat	FF	4	4IL	OC	77/80	1471	89.8	65	5600	7.40	C	W
Passat L, LS	FF											
1600	RR	4	4HO	OHV	86/69	1584	96.7	56	4200	7.20	2C	A
Brasilia	RR	4	4HO	OHV	86/69	1584	96.7	52	4200	7.20	2C	A
Variant II	RR	4	4HO	OHV	86/69	1584	96.7	56	4200	7.20	2C	A
Passat TS, LSE	FF	4	4IL	OC	80/80	1588	96.9	80	5600	7.50	C	W
CZECHOSLOVAKIA												
Skoda												
105 L, S (Estelle)	RR	4	4IL	OHV	68/72	1046	63.8	46	4800	8.50	C	W
110 R	RR	4	4IL	OHV	72/68	1107	67.6	52	4650	9.50	C	W
120 L (Estelle)	RR	4	4IL	OHV	72/72	1174	71.6	52	5000	8.50	C	W
120 LS (Estelle)	RR	4	4IL	OHV	72/72	1174	71.6	58	5200	9.20	C	W
Tatra												
T 613	RR	4	8V	TOC	85/77	3495	213.3	165	5200	9.20	2C	A

* FR–Front Engine Rear Drive, FF–Front Engine Front Drive, RR–Rear Engine Rear Drive, MR–Mid Engine Rear Drive

** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

†† G–Gross Rating

‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
FRANCE												
Chrysler France												
Simca 1005 LS	RR	4	4IL	OHV	68/65	944	57.6	40	5800	9.40	C	W
Simca 1100 LE Berline	FF	4	4TR	OHV	74/65	1118	68.2	50	5800	8.80	C	W
Simca 1006 GLS	RR	4	4IL	OHV	74/65	1118	68.2	55	5800	9.60	C	W
Simca 1100 ES, GLX, GLS	FF	4	4TR	OHV	74/65	1118	68.2	58	6000	9.60	C	W
Simca 1100 LE Break	FF											
Simca Horizon LS	FF	4	4TR	OHV	74/65	1118	68.2	56	5600	8.80	C	W
Simca Horizon GL	FF	4	4TR	OHV	74/65	1118	68.2	60	5600	9.60	C	W
Simca Rallye 1	RR	4	4IL	OHV	77/70	1294	79.0	60	5800	9.50	C	W
Simca Horizon GLS	FF	4	4TR	OHV	77/70	1294	79.0	68	5600	9.50	C	W
Simca 1307 GLS	FF											
Simca 1100 TI	FF	4	4TR	OHV	77/70	1294	79.0	82	6000	9.50	2C	W
Simca 1307 S	FF											
Simca 1000 Rallye 2	RR	4	4IL	OHV	77/70	1294	79.0	86	6200	9.50	2C	W
Simca 1308 GT	FF	4	4TR	OHV	77/78	1442	88.0	85	5600	9.50	C	W
Chrysler 1610	FR	4	4IL	OC	88/75	1812	110.6	100	5800	9.45	C	W
Chrysler 2L	FR	4	4IL	OC	92/75	1981	120.9	110	5800	9.45	C	W
Citroen												
2 CV Special	FF	4	2HO	OHV	69/59	435	26.5	24	6750	8.50	C	A
2 CV 4	FF											
2 CV 6	FF	4	2HO	OHV	74/70	602	36.7	26	5500	9.00	C	A
Ami 8	FF	4	2HO	OHV	74/70	602	36.7	32	5750	9.00	C	A
Dyane 6	FF											
LN	FF											
G Special	FF	4	4HO	OC	74/66	1129	68.9	56	5750	9.00	C	A
GS X	FF											
GS Club	FF	4	4HO	OC	77/66	1222	74.6	59	5750	8.20	C	A
GS Pallas	FF											
GS X 2	FF	4	4HO	OC	77/66	1222	74.6	64	5750	8.70	C	A
CX 2000	FF	4	4TR	OHV	86/86	1985	121.1	102	5500	9.00	C	W
CX 2200 Diesel	FF	4	4TR	OHV	90/86	2175	132.7	66	4500	22.25	MFI	W
CX 2400 Super	FF	4	4TR	OHV	94/86	2347	143.2	115	5500	8.75	C	W
CX 2400 Pallas	FF											
CX Prestige	FF											
CS 2400 GTI	FF	4	4TR	OHV	9486	2347	143.2	128	4800	8.75	EFI	W
CX Prestige	FF											
CX 2500 Diesel	FF	4	4TR	OHV	93/92	2500	152.6	75	4500	22.25	MFI	W
Peugeot												
104 GL5, ZL	FF	4	4TR	OC	70/62	954	58.2	44	6000	8.80	C	W
104 GL6, SL	FF	4	4TR	OC	72/69	1124	68.6	57	6000	9.20	C	W
104 ZS	FF	4	4TR	OC	72/69	1124	68.6	66	6200	9.20	C	W
304 GL Break	FF	4	4TR	OC	78/59	1127	68.8	59	6250	8.80	C	W
304 GL Berline	FF	4	4TR	OC	78/68	1290	78.7	65	6000	8.80	C	W
304 SL	FF											
305 GL, GR	FF											
304 SLS	FF	4	4TR	OC	78/68	1290	78.7	74	6000	8.80	C	W
304 GLD (Diesel)	FF	4	4TR	OC	78/71	1357	82.8	45	5000	23.30	MFI	W
305 SR	FF	4	4TR	OC	78/77	1472	89.8	74	6000	9.20	C	W
504 L Break	FR	4	4IL	OHV	84/81	1796	109.6	73	5000	7.50	C	W
504 L Berline	FR	4	4IL	OHV	84/81	1796	109.6	79	5100	7.50	C	W
504 LD Berline (Diesel)	FR	4	4IL	OHV	88/80	1948	118.9	55	4500	21.80	MFI	W

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
FRANCE (Cont'd.)												
Peugeot (Cont'd.)												
504 GL	FR	4	4IL	OHV	88/81	1971	120.3	96	5200	8.80	C	W
504 Familiale	FR											
504 TI	FR	4	4IL	OHV	88/81	1971	120.3	106	5200	8.80	MFI	W
504 Cabriolet	FR											
504 Coupe	FR											
504 LD Break (Diesel)	FR	4	4IL	OHV	90/83	2112	128.9	59	4500	22.20	MFI	W
504 GLD (Diesel)	FR	4	4IL	OHV	94/83	2304	140.6	70	4500	22.20	MFI	W
504 V6	FR	4	6V	OC	88/73	2664	162.6	114	5500	8.65	2C	W
604 SL	FR	4	6V	OC	88/73	2664	162.6	136	5750	8.65	2C	W
604 TI	FR	4	6V	OC	88/73	2664	162.6	144	5500	8.65	MFI	W
Renault												
4, 4 TL	FF	4	4IL	OHV	56/80	782	47.7	27	5000	8.50	C	W
4 Safari	FF											
6	FF	4	4IL	OHV	58/80	845	51.6	34	5000	8.00	C	W
5	FF	4	4IL	OHV	58/80	845	51.6	36	5500	8.00	C	W
5 TL	FF	4	4IL	OHV	65/72	956	58.3	44	5500	9.25	C	W
6 TL	FF	4	4IL	OHV	70/72	1108	67.6	47	5300	9.50	C	W
14, 14 TL	FF	4	4TR	OC	75/69	1218	74.3	57	6000	9.30	C	W
5 GTL	FF	4	4IL	OHV	73/77	1289	78.7	42	5000	9.50	C	W
12	FF	4	4IL	OHV	73/77	1289	78.7	50	5000	8.50	C	W
12 TL	FF	4	4IL	OHV	73/77	1289	78.7	54	5250	9.50	C	W
12 TS	FF	4	4IL	OHV	73/77	1289	78.7	60	5500	9.50	C	W
12 Automatic	FF											
15 TL, GTL	FF											
15 GTL Automatic	FF											
5 TS	FF	4	4IL	OHV	73/77	1289	78.7	64	6000	9.50	C	W
5 Alpine	FF	4	4IL	OHV	76/77	1397	85.2	93	6400	10.00	C	W
16 TL (55)	FF	4	4IL	OHV	77/84	1565	95.5	55	5000	8.00	C	W
16 TL (66)	FF	4	4IL	OHV	77/84	1565	95.5	66	5000	8.60	C	W
16 TL Automatic	FF	4	4IL	OHV	79/84	1647	100.5	68	5000	8.60	C	W
16 TX	FF	4	4IL	OHV	79/84	1647	100.5	90	6000	9.25	C	W
16 TX Automatic	FF											
20 TL, GTL	FF	4	4IL	OHV	79/84	1647	100.5	96	5750	9.30	C	W
20 TL Automatic	FF											
20 GTL Automatic	FF											
17 TS	FF	4	4IL	OHV	79/84	1647	100.5	98	5750	9.25	C	W
17 TS Automatic	FF											
20 TS	FF	4	4IL	OC	88/82	1995	121.7	110	5500	9.20	C	W
20 TS Automatic	FF											
30 TS	FF	4	6V	OC	88/73	2664	162.6	125	5000	8.65	C	W
30 TS Automatic	FF											
EAST GERMANY												
VEB AE												
Wartburg 353 W	FF	2	3IL	–	74/78	992	60.5	50	4250	7.50	C	W
VEB SAZ												
Trabant 601	FF	2	2TR	–	72/73	594	36.2	26	4200	7.60	C	A

* FR–Front Engine Rear Drive, FF–Front Engine Front Drive, RR–Rear Engine Rear Drive, MR–Mid Engine Rear Drive
** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse
† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts
†† G–Gross Rating
‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)
‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
WEST GERMANY												
BMW												
316	FR	4	4IL	OC	84/71	1573	96.0	90	6000	8.30	C	W
518	FR	4	4IL	OC	89/71	1766	107.8	90	5500	8.30	C	W
318	FR	4	4IL	OC	89/71	1766	107.8	98	5800	8.30	C	W
320	FR	4	6IL	OC	80/66	1990	121.4	122	6000	9.20	C	W
520	FR											
323 i	FR	4	6IL	OC	80/77	2315	141.3	143	6000	9.50	MFI	W
525	FR	4	6IL	OC	86/72	2494	152.2	150	6000	9.00	C	W
728	FR	4	6IL	OC	86/80	2788	170.1	170	5800	9.00	C	W
528 i	FR	4	6IL	OC	86/80	2788	170.1	177	5800	9.00	EFI	W
530 i (U.S.)	FR	4	6IL	OC	89/80	2986	182.2	175	5500	8.00	EFI	W
630 CS	FR	4	6IL	OC	89/80	2986	182.2	185	5800	9.00	C	W
730	FR											
733 i	FR	4	6IL	OC	89/86	3210	195.9	197	5500	9.00	EFI	W
633 CSi	FR	4	6IL	OC	89/86	3210	195.9	200	5500	9.00	EFI	W
Daimler-Benz (Mercedes-Benz)												
200 D (Diesel)	FR	4	4IL	OC	87/84	1988	121.3	55	4200	21.00	MFI	W
200	FR	4	4IL	OC	87/84	1988	121.3	94	4800	9.00	C	W
220 D (Diesel)	FR	4	4IL	OC	87/92	2197	134.1	60	4200	21.00	MFI	W
230	FR	4	4IL	OC	94/84	2307	140.8	109	4800	9.00	C	W
240 D (Diesel)	FR	4	4IL	OC	91/92	2404	146.7	65	4200	21.00	MFI	W
250	FR	4	6IL	OC	86/72	2525	154.1	129	5500	8.70	C	W
280	FR	4	6IL	TOC	86/79	2746	167.6	156	5500	8.70	C	W
280 C, S	FR											
280 E, CE, TE	FR	4	6IL	TOC	86/79	2746	167.6	177	6000	8.70	EFI	W
280 SE, SEL, SL, SLC	FR											
300 D (Diesel)	FR	4	5IL	OC	91/92	3005	183.4	80	4000	21.00	MFI	W
300 SD (U.S.) (Diesel)	FR	4	5IL	OC	91/92	3005	183.4	115	4200	21.50	MFI	W
350	FR	4	8V	OC	92/66	3499	213.5	195	5500	9.00	EFI	W
450 SE (U.S.)	FR	4	8V	OC	92/85	4520	275.8	190	5000	8.00	EFI	W
450	FR	4	8V	OC	92/85	4520	275.8	217	5000	8.80	EFI	W
450 SLC 5.0	FR	4	8V	OC	97/85	5025	306.6	240	5000	8.80	EFI	W
500	FR	4	8V	OC	103/95	6332	386.4	250	4000	9.00	MFI	W
450 SEL 6.9	FR	4	8V	OC	107/95	6834	417.0	286	4250	8.80	MFI	W
Ford Werke												
Fiesta 950	FF	4	4TR	OHV	74/56	957	58.4	40	5500	8.30	C	W
Fiesta 950 (Opt.)	FF	4	4TR	OHV	74/56	957	58.4	45	6000	9.00	C	W
Escort 1100 L, GL	FR	4	4IL	OHV	81/53	1098	67.0	44	5500	8.00	C	W
Fiesta 1100 S	FF	4	4TR	OHV	74/65	1117	68.2	53	5700	9.00	C	W
Taunus 1300	FR	4	4IL	OC	79/66	1294	79.0	55	5500	8.00	C	W
Capri II 1300 L	FR	4	4IL	OHV	81/63	1298	79.2	54	5500	8.00	C	W
Escort 1300	FR											
Escort 1300 (Opt.)	FR	4	4IL	OHV	81/63	1298	79.2	57	5500	9.20	C	W
Fiesta 1300	FF	4	4TR	OHV	81/63	1298	79.2	66	5600	9.20	C	W
Escort 1300 Ghia	FR	4	4IL	OHV	81/63	1298	79.2	70	5500	9.20	C	W
Escort 1300 Sport	FR											
Capri II 1600 (Opt.)	FR	4	4IL	OC	88/66	1593	97.2	68	5200	8.20	C	W
Taunus 1600 (Opt.)	FR											
Capri II 1600	FR	4	4IL	OC	88/66	1593	97.2	72	5000	9.20	C	W
Taunus 1600	FR											
Escort 1600 Ghia	FR	4	4IL	OHV	81/78	1598	97.5	84	5500	9.00	C	W
Escort 1600 Sport	FR											
Granada 1.7	FR	4	4V	OHV	90/67	1700	103.7	70	5000	7.75	C	W
Granada 1.7 (Opt.)	FR	4	4V	OHV	90/67	1700	103.7	73	5000	8.75	C	W

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
WEST GERMANY (Cont'd.)												
Ford Werke (Cont'd.)												
Taunus 2000 S	FR	4	4IL	OC	91/77	1993	121.6	98	5200	9.20	C	W
Escort RS 2000	FR	4	4IL	OC	91/77	1993	121.6	110	5500	9.20	C	W
Capri II 2000	FR	4	6V	OHV	84/60	1999	122.0	90	5000	8.75	C	W
Granada 2.0	FR											
Taunus 2000	FR											
Capri II 2300	FR	4	6V	OHV	90/60	2293	139.9	108	5000	8.75	C	W
Granada 2.3	FR											
Taunus 2300	FR											
Granada 2.8	FR	4	6V	OHV	93/69	2792	170.4	135	5200	9.20	C	W
Granada 2.8i	FR	4	6V	OHV	93/69	2792	170.4	160	5700	9.20	C	W
Capri 3000	FR	4	6V	OHV	94/72	2994	182.7	138	5000	9.00	C	W
Opel												
City 1.0	FR	4	4IL	OHV	72/61	993	60.6	40	5400	7.90	C	W
Kadett 1.0 (Opt.)	FR											
City (Export Opt.)	FR	4	4IL	OHV	72/61	993	60.6	48	5600	8.80	C	W
Kadett 1.0	FR											
Ascona 1.2 (Opt.)	FR	4	4IL	OHV	79/61	1196	73.0	55	5400	7.80	C	W
City 1.2	FR											
Kadett 1.2	FR											
Kadett 1.2 L	FR											
Kadett 1.2 Berlina	FR											
Manta 1.2 (Opt.)	FR											
Ascona 1.2	FR	4	4IL	OHV	79/61	1196	73.0	60	5400	9.10	C	W
City 1.2 (Opt.)	FR											
Kadett 1.2 Aero Cabriolet	FR											
Manta 1.2	FR											
Ascona 1.6	FR	4	4IL	OC	85/70	1584	96.7	60	5000	8.00	C	W
Manta 1.6	FR											
City 1.6	FR	4	4IL	OC	85/70	1584	96.7	75	5200	8.80	C	W
Rallye 1.6	FR											
Kadett 1.6	FR											
Rekord 1.7	FR	4	4IL	OC	88/70	1698	103.6	60	4800	8.00	C	W
Ascona 1.9	FR	4	4IL	OC	93/70	1897	115.8	75	4800	7.90	C	W
Manta 1.9	FR											
Rekord 1.9	FR											
Ascona 1.9 S	FR	4	4IL	OC	93/70	1897	115.8	90	5200	8.00	C	W
Manta 1.9 S	FR											
Rekord 1.9 S	FR											
Ascona 2.0 S	FR	4	4IL	OHV	95/70	1979	120.8	100	5400	9.00	C	W
Manta 2.0 S	FR											
Rekord 2.0 S	FR	4	4IL	OHV	95/70	1979	120.8	100	5200	9.00	C	W
Manta 2.0 GT/E	FR	4	4IL	OHV	95/70	1979	120.8	110	5400	9.40	EFI	W
Rallye E	FR											
Kadette 2.0 GT/E	FR	4	4IL	OHV	95/70	1979	120.8	115	5600	9.60	EFI	W
Rekord 2.1 Diesel	FR	4	4IL	OC	88/85	2068	126.2	60	4400	22.00	MFI	W
Commodore GS/E	FR	4	6IL	OC	92/70	2784	169.9	160	5400	9.50	EFI	W

* FR–Front Engine Rear Drive, FF–Front Engine Front Drive, RR–Rear Engine Rear Drive, MR–Mid Engine Rear Drive

** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

†† G–Gross Rating

‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

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BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
WEST GERMANY (Cont'd.)												
Porsche												
924	FR	4	4IL	OC	87/84	1984	121.1	125	5800	9.30	MFI	W
911 SC	RR	4	6HO	OC	95/70	2994	182.7	180	5500	8.50	MFI	A
911 SC Targa	RR											
Turbo (Turbocharged)	RR	4	6HO	OC	97/74	3299	201.3	300	5500	7.00	MFI	A
928	FR	4	8V	OC	95/79	4474	273.0	240	5500	8.50	MFI	W
Volkswagen												
VW Polo	FF	4	4TR	OC	70/59	895	54.6	40	5900	8.00	C	W
VW Polo L	FF											
VW Derby	FF											
VW Derby L	FF											
Audi 50 LS, GLS	FF	4	4TR	OC	70/72	1093	66.7	50	5800	8.00	C	W
VW Derby S, LS, GLS	FF											
VW Polo S, LS, GLS	FF											
VW Golf	FF	4	4TR	OC	70/72	1093	66.7	50	6000	8.00	C	W
VW Golf L, GL	FF											
VW Scirocco	FF											
VW Scirocco L	FF											
Audi 50 LS, GLS (Opt.)	FF	4	4IL 4TR	OC	75/72	1272	77.6	60	5600	8.20	C	W
VW Derby S, LS, GLS (Opt.)	FF											
VW Polo LS, GLS (Opt.)	FF											
Audi 80	FF	4	4IL	OC	75/73	1297	79.1	55	5500	8.50	C	W
Audi 80 L	FF											
VW Passat	FF											
VW Passat L	FF											
VW Golf S, LS, GLS	FF	4	4TR	OC	80/73	1457	88.9	70	5600	8.20	C	W
VW Scirocco GL, GT, S, LS	FF											
VW Golf Diesel	FF	4	4TR	OC	77/80	1471	89.8	50	5000	23.50	MFI	W
VW 1303	RR	4	4HO	OHV	86/69	1584	96.7	50	4000	7.50	C	A
Audi 80 S, LS, GLS	FF	4	4IL	OC	80/80	1588	96.9	75	5600	8.20	C	W
VW Passat S, LS, GLS	FF											
Audi 80 LS, GLS (Opt.)	FF	4	4IL	OC	80/80	1588	96.9	85	5600	8.20	C	W
Audi 100	FF											
Audi 100 L, GL	FF											
Audi 100 Avant L, GL	FF											
VW Passat LS, GLS (Opt.)	FF											
Audi 80 GTE	FF	4	4IL 4TR	OC	80/80	1588	96.9	110	6100	9.50	MFI	W
VW Golf GTI	FF											
VW Scirocco GLI, GTI	FF											
Audi 100 S, LS, GLS	FF	4	4IL	OC	87/84	1984	121.1	115	5500	9.30	C	W
Audi 100 Avant LS, GLS	FF											
Audi 100 SE, LS, GLSE	FF	4	5IL	OC	80/86	2144	130.8	136	5700	9.30	MFI	W
Audi 100 Avant LSE, GLSE	FF											
GREAT BRITAIN												
Aston Martin Lagonda												
Aston Martin Lagonda	FR	4	8V	TOC	100/85	5340	325.7	–	–	9.00	4C	W
Aston Martin V8	FR											
Aston Martin V8 Vantage	FR											

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
GREAT BRITAIN (Cont'd.)												
Bristol Cars												
603 E, S2	FR	4	8V	OHV	99/84	5211	318.0	–	–	8.50	C	W
412 S2	FR	4	8V	OHV	102/91	5900	360.0	–	–	8.40	C	W
British Leyland												
Mini 850	FF	4	4TR	OHV	63/68	848	51.7	33	5300	8.30	C	W
Mini 1000	FF	4	4TR	OHV	65/76	998	60.9	39	4750	8.30	C	W
Austin Allegro 1100	FF	4	4TR	OHV	64/84	1098	67.0	45	5250	8.50	C	W
Mini Clubman	FF											
Austin Allegro 1300	FF	4	4TR	OHV	71/81	1275	77.8	54	5250	8.80	C	W
Mini 1275 GT	FF											
Morris Marina 1.3	FR	4	4IL	OHV	71/81	1275	77.8	57	5500	8.80	C	W
Triumph Dolomite 1300	FR	4	4IL	OHV	74/76	1296	79.1	58	5500	8.50	C	W
Austin Allegro 1500	FF	4	4TR	OC	76/81	1485	90.6	68	5500	9.00	C	W
Austin Maxi 1500	FF											
Vanden Plas 1500	FF											
MG Midget	FR	4	4IL	OHV	74/88	1493	91.1	65	5500	9.00	2C	W
Triumph Dolomite 1500	FR	4	4IL	OHV	74/88	1493	91.1	71	5500	9.00	2C	W
Triumph Spitfire	FR											
Austin Maxi 1750	FF	4	4TR	OC	76/96	1748	106.7	72	4900	8.75	C	W
Austin Allegro 1750	FF	4	4TR	OC	76/96	1748	106.7	90	5500	9.50	2C	W
Austin Maxi 1750 HL	FF	4	4TR	OC	76/96	1748	106.7	91	5250	9.50	2C	W
Morris Marina 1.8 Special	FR	4	4IL	OHV	80/89	1798	109.7	72	4750	9.00	C	W
Morris Marina 1.8 Super	FR											
Princess 1800	FF	4	4TR	OHV	80/89	1798	109.7	82	5250	9.00	C	W
Morris Marina 1.8 GT	FR	4	4IL	OHV	80/89	1798	109.7	85	5500	9.00	2C	W
Morris Marina 1.8 HL	FR											
MG MGB	FR	4	4IL	OHV	80/89	1798	109.7	97	5500	9.00	2C	W
MG MGB GT	FR											
Triumph Dolomite 1850	FR	4	4IL	OC	87/78	1854	113.1	91	5200	9.00	2C	W
Triumph TR 7	FR	4	4IL	OC	90/78	1998	121.9	105	5500	9.25	2C	W
Triumph Dolomite Sprint	FR	4	4IL	OC	90/78	1998	121.9	127	5700	9.50	2C	W
Princess 2200	FF	4	4TR	OC	76/81	2227	135.9	110	5250	9.00	2C	W
Rover 2300	FR	4	6IL	OC	81/76	2350	143.4	123	5000	9.25	2C	W
Rover 2600	FR	4	6IL	OC	81/84	2597	158.5	136	5000	9.25	2C	W
Daimler Sovereign 3.4	FR	4	6IL	TOC	83/106	3442	210.0	161	5250	8.50	2C	W
Jaguar XJ 3.4	FR											
Rover 3500	FR	4	8V	OHV	89/71	3528	215.3	155	5250	9.35	2C	W
Daimler Limousine	FR	4	6IL	TOC	92/106	4235	258.4	162	4250	7.50	2C	W
Daimler Sovereign 4.2	FR	4	6IL	TOC	92/106	4235	258.4	166	4750	7.80	2C	W
Jaguar XJ 4.2	FR											
Vanden Plas 4.2	FR											
Daimler Double-Six	FR	4	12V	OC	90/70	5343	326.0	264	5750	9.00	EFI	W
Jaguar XJ-S	FR											
Jaguar XJ 5.3	FR											
Vanden Plas Double-Six	FR											

* FR–Front Engine Rear Drive, FF–Front Engine Front Drive, RR–Rear Engine Rear Drive, MR–Mid Engine Rear Drive

** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

†† G–Gross Rating

‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
GREAT BRITAIN (Cont'd.)												
Chrysler UK												
Sunbeam 1.0 LS, GL	FR	4	4IL	OC	70/60	928	56.6	42	5000	9.00	C	W
Alpine GL	FF	4	4TR	OHV	77/70	1294	79.0	68	5600	9.50	C	W
Avenger 1.3 LS, GL	FR	4	4IL	OHV	79/67	1295	79.0	59	5000	8.80	C	W
Sunbeam 1.3 LS, GL	FR											
Alpine S, GLS	FF	4	4TR	OHV	77/78	1442	88.0	85	5600	9.50	C	W
Alpine 1.4 GL	FF											
Avenger 1.6 GL, LS	FR	4	4IL	OHV	87/67	1598	97.5	69	4800	8.80	C	W
Sunbeam 1.6 GL, S	FR											
Avenger 1.6 GLS	FR	4	4IL	OHV	87/67	1598	97.5	80	5400	8.80	C	W
Hunter DL	FR	4	4IL	OHV	82/83	1725	105.3	61	4700	8.40	C	W
Hunter Super	FR	4	4IL	OHV	82/83	1725	105.3	74	5100	9.20	C	W
Ford Motor												
Fiesta 950	FF	4	4TR	OHV	74/56	957	58.4	40	5500	8.30	C	W
Fiesta 950 L	FF											
Fiesta 950 (Opt.)	FF	4	4TR	OHV	74/56	957	58.4	45	6000	9.00	C	W
Fiesta 950 L (Opt.)	FF											
Escort Popular 1100	FR	4	4IL	OHV	81/53	1098	67.0	41	5300	9.00	C	W
Escort 1100 L	FR											
Fiesta 1100 Ghia	FF	4	4TR	OHV	74/65	1117	68.2	53	6000	9.00	C	W
Fiesta 1100 S	FF											
Cortina 1300	FR	4	4IL	OHV	81/63	1298	79.2	50	5000	9.20	C	W
Capri II 1300	FR	4	4IL	OHV	81/63	1298	79.2	57	5500	9.20	C	W
Escort 1300	FR											
Escort Popular 1300	FR											
Fiesta 1300 Ghia	FF	4	4TR	OHV	81/63	1298	79.2	66	5600	9.20	C	W
Fiesta 1300 S	FF											
Escort 1300 Ghia	FR	4	4IL	OHV	81/63	1298	79.2	70	5500	9.20	C	W
Escort 1300 Sport	FR											
Cortina 1600	FR	4	4IL	OC	88/66	1593	97.2	59	4500	9.20	C	W
Capri II 1600 L, GL	FR	4	4IL	OC	88/66	1593	97.2	72	5200	9.20	C	W
Cortina 1600 L, GL	FR											
Capri II 1600 S	FR	4	4IL	OC	88/66	1593	97.2	88	5700	9.20	C	W
Cortina 1600 Ghia	FR											
RS Mexico	FR	4	4IL	OC	88/66	1593	97.2	95	5750	9.20	C	W
Escort 1600 Ghia	FR	4	4IL	OHV	81/78	1598	97.5	84	5500	9.00	C	W
Escort 1600 Sport	FR											
Escort RS 1800	FR	4	4IL	TOC	87/78	1834	111.9	115	6000	9.00	C	W
Capri II 2000	FR	4	4IL	OC	91/77	1993	121.6	98	5200	9.20	C	W
Cortina 2000	FR											
Granada 2000	FR											
Granada 2100 Diesel (Peugeot)	FR	4	4IL	OHV	90/83	2112	128.9	63	4500	22.80	MFI	W
Cortina 2300	FR	4	6V	OHV	90/60	2293	139.9	108	5000	8.75	C	W
Granada 2300	FR											
Granada 2800	FR	4	6V	OHV	93/69	2792	170.4	135	5200	9.20	C	W
Granada 2800i	FR	4	6V	OHV	93/69	2792	170.4	160	5200	9.20	MFI	W
Capri II 3000	FR	4	6V	OHV	94/72	2994	182.7	138	5000	9.00	C	W
Rolls-Royce Motors												
Rolls-Royce Phantom VI	FR	4	8V	OHV	104/91	6230	380.2	–	–	9.00	2C	W
Bentley T2	FR	4	8V	OHV	104/99	6750	411.9	–	–	8.00	2C	W
Bentley Corniche	FR											
Rolls-Royce Silver Shadow	FR											
Rolls-Royce Silver Wraith	FR											
Rolls-Royce Corniche	FR											

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
GREAT BRITAIN (Cont'd.)												
Vauxhall Motors												
Cavalier 1300	FR	4	4IL	OHV	81/61	1256	76.6	58	5600	8.70	C	W
Chevette E, L	FR											
Chevette GL, GLS	FR											
Viva 1300	FR											
Cavalier 1600	FR	4	4IL	OHV	85/70	1584	96.7	75	5000	8.80	C	W
Magnum 1800	FR	4	4IL	OC	86/76	1759	107.3	88	5800	8.50	C	W
Viva 1800	FR											
VX 1800	FR											
Cavalier 2000	FR	4	4IL	OC	95/70	1979	120.8	100	5400	9.00	C	W
Magnum 2300	FR	4	4IL	OC	98/76	2279	139.1	108	5000	8.50	C	W
VX 2300	FR											
VX 4/90	FR	4	4IL	OC	98/76	2279	139.1	116	5000	8.50	2C	W
Chevette 2300 HS	FR	4	4IL	TOC	98/76	2279	139.1	135	5500	8.20	2C	W
HOLLAND												
Volvo												
66 DL	FR	4	4IL	OHV	70/72	1108	67.6	47	5000	8.50	C	W
66 GL	FR	4	4IL	OHV	73/77	1289	78.7	57	5200	8.50	C	W
343 L	FR	4	4IL	OHV	76/77	1397	85.2	70	5500	9.50	C	W
343 DL	FR											
ITALY												
Alfa Romeo												
Alfasud	FF	4	4HO	TOC	80/59	1186	72.4	63	6000	8.80	C	W
Alfasud Super	FF											
Alfasud Super 1.3	FF	4	4HO	TOC	80/64	1286	78.3	68	6000	9.00	C	W
Alfasud Giardinetta 1.3	FF											
Alfasud ti 1300	FF	4	4HO	TOC	80/64	1286	78.5	76	6000	9.00	C	W
Alfasud Sprint	FF											
Spider Junior 1300	FR	4	4IL	TOC	74/75	1290	78.7	89	6000	9.00	2C	W
Giulietta 1.3	FR	4	4IL	TOC	80/68	1357	82.8	95	6000	9.00	2C	W
Alfetta 1.6	FR	4	4IL	TOC	78/82	1570	95.8	109	5600	9.00	2C	W
Alfetta GT 1.6	FR											
Giulietta 1.6	FR											
Spider Junior 1600	FR	4	4IL	TOC	78/82	1570	95.8	116	5500	9.00	2C	W
Giulia Diesel	FR	4	4IL	OHV	–	1760	107.4	52	4000	–	MFI	W
Alfetta 1.8	FR	4	4IL	TOC	80/88	1779	108.6	118	5300	9.50	2C	W
Alfetta 2000	FR	4	4IL	TOC	84/88	1962	119.7	122	5300	9.00	2C	W
Alfetta GTV	FR											
2000 Spider Veloce	FR	4	4IL	TOC	84/88	1962	119.7	128	5300	9.00	2C	W

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** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

†† G–Gross Rating

‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
ITALY (Cont'd.)												
Ferrari												
Dino 208 GT 4	MR	4	8VTR	TOC	67/71	1991	121.5	170	7700	9.00	4C	W
Dino 308 GT 4	MR	4	8VTR	TOC	81/71	2926	178.6	255	7600	8.80	4C	W
Dino 308 GTB	MR											
Dino 308 GTS	MR											
400 Automatic	FR	4	12V	TOC	81/78	4823	294.3	340	6500	8.80	6C	W
BB 512	RR	4	12HO	TOC	82/78	4942	301.6	360	6800	9.30	4C	W
Fiat												
126	RR	4	2IL	OHV	77/70	652	39.8	24	4500	7.50	C	A
Pulmino 900 T	RR	4	4IL	OHV	65/68	903	55.1	35	4800	7.90	C	W
Autobianchi A 112 N	FF	4	4TR	OHV	65/68	903	55.1	42	5400	9.00	C	W
127-900	FF	4	4TR	OHV	65/68	903	55.1	45	5600	9.00	C	W
Autobianchi A 112 Elegant	FF	4	4TR	OHV	67/68	965	58.9	48	5600	9.20	C	W
127-1050	FF	4	4TR	OC	76/58	1049	64.0	50	5600	9.30	C	W
Autobianchi A 112 Abarth	FF	4	4TR	OHV	67/74	1050	64.1	70	6600	10.40	C	W
128 Base 1100	FF	4	4TR	OC	80/56	1116	68.1	55	6000	9.20	C	W
128 Confort 1100	FF											
128 3P 1100	FF	4	4TR	OC	80/56	1116	68.1	65	6000	9.20	C	W
128 Base 1300	FF	4	4TR	OC	86/56	1290	78.7	60	6000	9.20	C	W
128 Confort 1300	FF											
128 3P 1300	FF	4	4TR	OC	86/56	1290	78.7	73	6000	9.20	C	W
X 1/9	MR											
131 Mirafiori 1300	FR	4	4IL	OHV	76/72	1297	79.1	65	5400	9.20	C	W
131 Mirafiori 1600	FR	4	4IL	OHV	84/72	1585	96.7	75	5400	9.20	C	W
132 1600	FR	4	4IL	TOC	84/72	1585	96.7	98	5600	9.00	C	W
132 2000	FR	4	4IL	TOC	84/90	1995	121.7	112	5600	8.90	C	W
131 Abarth Rally	FR	4	4IL	TOC	84/90	1995	121.7	140	6400	10.00	C	W
Lamborghini												
Urraco P 200	MR	4	8VTR	TOC	77/53	1994	121.7	182	7500	9.80	4C	W
Urraco P 250	MR	4	8VTR	TOC	86/53	2463	150.3	220	7500	10.40	4C	W
Urraco P 300	MR	4	8VTR	TOC	86/65	2996	182.8	265	7800	10.10	4C	W
Silhouette P 300	MR											
Espada 400 GT	FR	4	12V	TOC	82/62	3929	239.8	350	7500	10.50	6C	W
Countach LP 400 S	RR	4	12V	TOC	82/62	3929	239.8	375	8000	10.50	6C	W
Lancia												
Beta 1300	FF	4	4TR	TOC	76/72	1297	79.1	82	5800	8.90	C	W
Beta 1600	FF	4	4TR	TOC	84/72	1585	96.7	100	5800	9.40	C	W
Beta 2000	FF	4	4TR	TOC	84/90	1995	121.7	115	5500	8.90	C	W
Beta Montecarlo	MR	4	4TR	TOC	84/90	1995	121.7	120	6000	9.35	C	W
Gamma 2000	FF	4	4HO	OC	92/76	1999	122.0	120	5500	9.00	C	W
Stratos	MR	4	6VTR	TOC	92/60	2418	147.6	190	7000	9.00	3C	W
Gamma 2500	FF	4	4HO	OC	102/76	2484	151.6	140	5400	9.00	C	W
Maserati												
Merak 2000	MR	4	6V	TOC	80/66	1999	122.0	170	7000	9.00	3C	W
Merak SS	MR	4	6V	TOC	92/75	2965	180.9	220	6500	9.00	3C	W
Kyalami	FR	4	8V	TOC	88/85	4136	252.4	270	6000	8.50	4C	W
Bora 4900	FR	4	8V	TOC	94/89	4930	300.8	320	5500	8.50	4C	W
Khamsin	FR											
Nuova Innocenti												
Mini 90	FF	4	4TR	OHV	65/76	998	60.9	49	5600	9.00	C	W
Mini 120	FF	4	4TR	OHV	71/81	1275	77.8	65	5600	9.75	C	W
Mini De Tomaso	FF	4	4TR	OHV	71/81	1275	77.8	77	6100	9.75	C	W

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
JAPAN												
Daihatsu Kogyo												
Max Cuore	FF	4	2TR	OC	72/68	547	33.4	28G	6000	8.70	C	W
Charade	FF	4	3TR	OHV	76/73	993	60.6	55G	5500	8.70	C	W
Charmant 1200	FR	4	4IL	OHV	75/66	1166	71.2	64G	5800	9.00	C	W
Charmant 1400	FR	4	4IL	OHV	80/70	1407	85.9	82G	5800	9.00	C	W
Delta Wagon	FR	4	4IL	OHV	85/70	1588	96.9	85G	5400	8.50	C	W
Fuji Heavy Industries (Subaru)												
Rex 550	RR	4	2TR	OC	76/60	544	33.2	31G	6200	8.50	C	W
Leone 1400	FF	4	4HO	OHV	85/60	1361	83.1	72G	6000	8.50	C	W
Leone 1600 DL, C, SC, GL	FF	4	4HO	OHV	92/60	1595	97.3	82G	5600	8.50	C	W
Leone 1600 GF, Grand Am	FF											
Leone 1600 Super, RX, GFT	FF	4	4HO	OHV	92/60	1595	97.3	95G	6400	9.50	2C	W
Leone 1600 Grand Am T	FF											
Honda Motor												
Civic CVCC 1200	FF	4	4TR	OC	72/76	1238	75.5	65G	5500	7.90	C	W
Civic CVCC 1500 St. Wag.	FF	4	4TR	OC	74/86	1488	90.8	70G	5500	7.90	C	W
Civic CVCC 1500	FF	4	4TR	OC	74/86	1488	90.8	75G	5500	7.90	C	W
Accord (U.S.A.)	FF	4	4TR	OC	74/93	1599	97.6	68G	5000	8.00	C	W
Accord	FF	4	4TR	OC	74/93	1599	97.6	82G	5800	8.00	C	W
Isuzu Motors												
Gemini 1600	FR	4	4IL	OC	82/75	1584	96.7	100G	6000	8.70	C	W
Gemini Minx	FR											
Florian SII 1800	FR	4	4IL	OC	84/82	1817	110.9	105G	5400	8.70	C	W
117 XT	FR											
Gemini 1800	FR	4	4IL	OC	84/82	1817	110.9	110G	5600	8.50	C	W
117 XC, XC-J	FR	4	4IL	OC	84/82	1817	110.9	115G	5800	9.00	EFI	W
117 XE, XG	FR	4	4IL	TOC	84/82	1817	110.9	130G	6400	9.00	EFI	W
Florian SII Diesel 2000	FR	4	4IL	OHV	86/84	1951	119.1	62G	4400	20.00	MFI	W
Mitsubishi Motors												
Minica Ami 55	FR	4	2IL	OC	70/71	546	33.3	31G	6000	9.00	C	W
Lancer 1200	FR	4	4IL	OC	70/82	1244	75.9	70G	5500	9.00	C	W
Celeste 1400	FR	4	4IL	OC	73/86	1439	87.8	82G	5400	9.00	C	W
Lancer 1400	FR											
Celeste 1600 GL, XL, GT	FR	4	4IL	OC	77/86	1597	97.4	86G	5000	8.50	C	W
Galant Lambda 1600 SL	FR											
Galant Sigma 1600	FR											
Lancer 1600 GSL	FR											
Celeste 1600 GSR	FR	4	4IL	OC	77/86	1597	97.4	100G	6300	9.50	2C	W
Galant Lambda 1600 GS	FR											
Lancer 1600 GSR	FR											
Galant Sigma 1850	FR	4	4IL	OC	81/90	1855	113.2	97G	5700	8.50	C	W

* FR–Front Engine Rear Drive, FF–Front Engine Front Drive, RR–Rear Engine Rear Drive, MR–Mid Engine Rear Drive

** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

†† G–Gross Rating

‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
Mitsubishi Motors (Cont'd.)				JAPAN (Cont'd.)								
Galant Lambda 2000 GSL, Super	FR	4	4IL	OC	84/90	1995	121.7	105G	5400	8.50	C	W
Galant Sigma 2000 GLX, GSL	FR											
Galant Sigma 2000 Super	FR											
Galant Lambda 2000 GSR	FR	4	4IL	OC	84/90	1995	121.7	115G	6000	9.50	2C	W
Galant Sigma 2000 GSR	FR											
Debonair Executive	FR	4	4IL	OC	91/98	2555	155.9	120G	5000	8.20	C	W
Nissan Motor (Datsun)												
Cherry FII 1000	FF	4	4TR	OHV	73/59	988	60.3	59G	6000	9.00	C	W
Cherry FII 1200	FF	4	4TR	OHV	73/70	1171	71.5	68G	6000	9.00	C	W
Sunny 1200	FR	4	4IL	OHV	75/70	1237	75.5	70G	6000	9.00	C	W
Cherry FII 1400	FF	4	4TR	OHV	76/77	1397	85.2	80G	6000	8.50	C	W
Datsun F 10 (U.S.A.)	FF											
Auster 1400	FR	4	4IL	OHV	76/77	1397	85.2	80G	6000	9.00	C	W
Sunny 1400	FR											
Violet 1400	FR											
Cherry FII 1400 Twin	FF	4	4TR	OHV	76/77	1397	85.2	92G	6400	8.50	2C	W
Auster 1600	FR	4	4IL	OC	83/74	1595	97.3	100G	6000	8.50	C	W
Bluebird 1600	FR											
Skyline 1600	FR											
Stanza L, X, TS	FR											
Violet 1600	FR											
Auster CS-E, CS-LE	FR	4	4IL	OC	83/74	1595	97.3	110G	6200	9.00	EFI	W
Stanza GT-E, TS-E	FR											
Stanza Maxima GT-E	FR											
Violet GL-EL	FR											
Bluebird 1800 GL, SSS	FR	4	4IL	OC	85/78	1770	108.0	105G	6000	8.50	C	W
Laurel 1800	FR											
Silvia LS	FR											
Skyline 1800 TI, TI-L	FR											
Bluebird 1800 GL-E, SSS	FR	4	4IL	OC	85/78	1770	108.0	115G	6200	8.50	EFI	W
Silvia LS-E	FR											
Skyline 1800 TI-EL, ES	FR											
Gloria 2000 Diesel	FR	4	4IL	OHV	83/92	1991	121.5	60G	4000	20.00	MFI	W
Bluebird 2000 G6, G6L	FR	4	6IL	OC	78/70	1998	121.9	115G	5600	8.50	C	W
Cedric 2000 DL, CDL, GL	FR											
Laurel 2000 G6L, SGL	FR											
Skyline 2000 GT, GT-L	FR											
Bluebird 2000 G6, G6L	FR	4	6IL	OC	78/70	1998	121.9	130G	6000	8.60	EFI	W
Cedric 2000	FR											
Fairlady GL-E, SGL-E	FR											
Laurel 2000 GL6-E, SGL-E	FR											
Skyline 2000 GT-E, EL, EX, ES	FR											
Gloria 2200 Diesel	FR	4	4IL	OHV	83/100	2164	132.1	65G	4000	20.80	MFI	W
Bluebird (U.S.A.)	FR	4	6IL	OC	83/74	2393	146.0	130G	6000	8.60	EFI	W
Gloria 2800 SGL	FR	4	6IL	OC	86/79	2753	168.0	140G	5200	8.30	C	W
Laurel 2800 SGL	FR											
Gloria 2800 Brougham	FR	4	6IL	OC	86/79	2753	168.0	145G	5200	8.50	EFI	W
Datsun 280Z	FR	4	6IL	OC	86/79	2753	168.0	149G	5600	8.30	2C	W
President	FR	4	8V	OHV	92/83	4414	269.3	200G	4800	8.60	EFI	W
Suzuki Motor												
Fronte Hatch 55	FR	2	3IL	–	61/62	539	32.9	25G	4500	6.40	C	W
Fronte 7-S	RR	2	3TR	–	61/62	539	32.9	28G	5000	7.00	C	W
Fronte 7-S	RR	4	2TR	OC	72/68	547	33.4	28G	6000	8.70	C	W

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JAPAN (Cont'd.)												
Toyo Kogyo (Mazda)												
Familia GLC (U.S.A.)	FR	4	4IL	OC	73/76	1272	77.6	52G	5000	9.20	C	W
Familia AP	FR	4	4IL	OC	73/76	1272	77.6	72G	5700	9.20	C	W
Grand Familia 1300 AP	FR											
Capella 1600 AP	FR	4	4IL	OC	78/83	1586	96.8	90G	6000	8.60	C	W
Grand Familia 1600 AP	FR											
Capella 1800 AP	FR	4	4IL	OC	80/88	1769	107.9	100G	6000	8.60	C	W
Cosmo 1800 AP	FR											
Luce 1800	FR											
Cosmo 2000 AP	FR	4	4IL	OC	80/98	1970	120.2	110G	5300	8.60	C	W
Cosmo L 2000 AP	FR											
Luce 2000	FR											
Capella RE-AP	FR	4	– – Rotary – –			573x2	35.0x2	125G	6500	9.40	C	W
Cosmo AP, L RE	FR											
Luce RE	FR											
Cosmo AP Limited	FR	4	– – Rotary – –			654x2	39.9x2	135G	6000	9.40	C	W
Cosmo L RE Limited	FR											
Luce RE Limited	FR											
Roadpacer Sedan	FR											
Toyota Motor												
Publica	FR	4	4IL	OHV	75/66	1166	71.2	64G	5800	9.00	C	W
Starlet	FR											
Corolla 1300	FR	4	4IL	OHV	75/73	1290	78.7	72G	5600	9.00	C	W
Sprinter 1300	FR											
Corolla 1400	FR	4	4IL	OHV	80/70	1407	85.9	82G	5800	8.50	C	W
Sprinter 1400	FR											
Carina 1600	FR	4	4IL	OHV	85/70	1588	96.9	88G	5600	9.00	C	W
Celica 1600 ET, LT, ST, XT	FR											
Corolla 1600 HDL, GSL	FR											
Corona 1600 DL, GL	FR											
Sprinter 1600 GS, SR, XL	FR											
Corolla 1600 Automatic	FR	4	4IL	OHV	85/70	1588	96.9	90G	6000	9.00	C	W
Corona 1600 Std., SL	FR											
Corona 1600 Automatic	FR											
Sprinter 1600 Automatic	FR											
Celica 1600 GT, GTV	FR	4	4IL	TOC	85/70	1588	96.9	110G	6000	9.00	EFI	W
Corolla 1600 Levin, GT	FR											
Sprinter 1600 GT	FR											
Carina 1800	FR	4	4IL	OHV	85/78	1770	108.0	95G	5400	9.00	C	W
Celica 1800	FR											
Corona 1800	FR											
Chaser 1800	FR	4	4IL	OC	85/78	1770	108.0	95G	5700	9.00	C	W
Mark II 1800	FR											
Carina 1800 Automatic	FR	4	4IL	OC	85/78	1770	108.0	98G	5700	9.00	C	W
Celica 1800 Automatic	FR											
Chaser 1800 Automatic	FR											
Corona 1800 Automatic	FR											
Mark II 1800 Automatic	FR											

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** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

†† G–Gross Rating

‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
JAPAN (Cont'd.)												
Toyota Motor (Cont'd.)												
Corona 2000 DE, GL	FR	4	4IL	OHV	88/80	1968	120.1	88G	5000	8.00	C	W
Carina 2000 SDL, SE, ST	FR	4	4IL	OC	88/80	1968	120.1	100G	5500	8.50	C	W
Celica 2000 SE, ST, XT	FR											
Chaser 2000 DL, GS, XL	FR											
Mark II 2000 Std., DL, GS, XL	FR											
Carina 2000 GT	FR	4	4IL	TOC	88/80	1968	120.1	130G	6000	8.30	2C	W
Celica 2000 GT, GTV	FR											
Corona 2000 GT	FR											
Chaser 2000 SXL	FR	4	6IL	OC	75/75	1988	121.3	110G	5600	9.00	C	W
Crown 2000 DL, Super	FR											
Mark II 2000 L, LG	FR											
Chaser 2000 EFI	FR	4	6IL	OC	75/75	1988	121.3	125G	6000	8.50	EFI	W
Crown 2000 EFI	FR											
Mark II 2000 EFI	FR											
Crown 2200 Diesel	FR	4	4IL	OC	90/86	2188	133.5	72G	4200	21.50	MFI	W
Crown 2600	FR	4	6IL	OC	80/85	2563	156.4	135G	5400	8.50	C	W
Mark II 2600	FR											
Century	FR	4	8V	OHV	83/78	3376	206.0	170G	5400	8.50	C	W
POLAND												
FS Malolitrazowych												
Syrena 105	FF	2	3IL	–	70/73	842	51.4	40	4300	7.20	C	W
FS Osobowych												
Polski-Fiat 126 P	RR	4	2IL	OHV	74/70	594	36.2	23	4800	7.50	C	A
Polski-Fiat 125 P 1300	FR	4	4IL	OHV	72/80	1295	79.0	65	5200	9.00	C	W
Polski-Fiat 125 P 1500	FR	4	4IL	OHV	77/80	1481	90.4	75	5400	9.00	C	W
SPAIN												
Chrysler Espana												
Simca 1200 L, LS	FF	4	4TR	OHV	74/65	1118	68.2	52	5900	8.20	C	W
Simca 1200 LX, GLS	FF	4	4TR	OHV	77/70	1294	79.0	65	6000	9.50	C	W
Simca 1200 Special TI	FF	4	4TR	OHV	77/78	1442	88.0	85	5600	8.20	C	W
Chrysler Diesel	FR	4	4IL	OHV	82/95	2007	122.5	65	4000	21.00	MFI	W
Dodge 3700 Nuevo	FR	4	6IL	OHV	86/105	3687	225.0	165G	4200	8.40	C	W
Dodge 3700 GT	FR											
FASA-Renault												
4, 4TL	FF	4	4IL	OHV	61/72	852	52.0	32	5000	8.00	C	W
5, 5TL	FF	4	4IL	OHV	65/72	956	58.3	44	5500	9.25	C	W
6	FF											
5 GTL	FF	4	4IL	OHV	88/72	1037	63.3	50	5500	9.50	C	W
6 TL	FF											
Siete, Siete TL	FF											
12, 12 TL	FF	4	4IL	OHV	73/77	1289	78.7	57	5300	8.50	C	W
5 TS	FF	4	4IL	OHV	73/77	1289	78.7	64	5500	9.50	C	W
12 TS	FF	4	4IL	OHV	76/77	1397	85.2	70	5500	9.20	C	W
5 Copa	FF	4	4IL	OHV	76/77	1397	85.2	93	6400	10.00	C	W

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SPAIN (Cont'd.)												
Seat												
133	RR	4	4IL	OHV	65/64	843	51.4	34	4800	8.00	C	W
133 Especial	RR	4	4IL	OHV	65/64	843	51.4	44	6400	9.00	C	W
127	FF	4	4TR	OHV	65/88	903	55.1	45	5600	9.00	C	W
124-D, 124-D LS	FR	4	4IL	OHV	73/72	1197	73.0	65	5600	8.80	C	W
128 1200	FF	4	4TR	OHV	73/72	1197	73.0	67	5600	8.80	C	W
Sport 1200	FF											
124-D Especial	FR	4	4IL	OHV	80/72	1438	87.7	75	5400	9.00	C	W
131-L	FR											
128 1430	FF	4	4IL	OHV	80/72	1438	87.7	77	5600	9.00	C	W
Sport 1430	FF											
131-E	FR	4	4IL	TOC	80/79	1592	97.1	95	6000	9.00	C	W
132-L	FR	4	4IL	TOC	84/79	1756	107.2	107	6000	8.90	C	W
132 Automatic	FR											
132 Diesel	FR	4	4IL	OC	87/84	1988	121.3	55	4200	21.00	MFI	W
SWEDEN												
Saab												
95 GL	FF	4	4V	OHV	90/59	1498	91.4	68	5500	9.00	C	W
96 GL	FF											
99 L, GL	FF	4	4IL	OC	90/78	1985	121.1	100	5200	9.20	C	W
99 GL Super	FF	4	4IL	OC	90/78	1985	121.1	108	5200	9.20	2C	W
99 GL Injection (U.S.A.)	FF	4	4IL	OC	90/78	1985	121.1	115	5500	9.20	MFI	W
99 GLE (U.S.A.)	FF											
99 EMS (U.S.A.)	FF											
99 GLE	FF	4	4IL	OC	90/78	1985	121.1	118	5500	9.20	MFI	W
99 EMS	FF											
Turbo (Turbocharged)	FF	4	4IL	OC	90/78	1985	121.1	145	5000	7.20	MFI	W
Volvo												
242 L, DL	FR	4	4IL	OHV	89/80	1986	121.2	90	5000	8.50	C	W
244 L, DL	FR											
245 L, DL	FR											
242 DL (Opt.)	FR	4	4IL	OC	92/80	2127	129.8	100	5250	8.50	C	W
244 DL (Opt.)	FR											
245 DL (Opt.)	FR											
242 GT	FR	4	4IL	OC	92/80	2127	129.8	123	5500	9.30	MFI	W
244 GL	FR											
245 DLE	FR											
264 DL	FR	4	6V	OC	88/73	2664	162.6	125	5250	8.70	C	W
265 DL	FR											
262 C	FR	4	6V	OC	88/73	2664	162.6	140	6000	8.70	EFI	W
264 GL, GLE, TE	FR											
265 GL, GLE	FR											

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‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)

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Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
UNITED STATES												
American Motors												
Gremlin	FR	4	4IL	OHV	87/84	1983	121	80	5000	8.20	C	W
Concord	FR	4	6IL	OHV	95/89	3802	232	90	3400	8.00	C	W
Pacer	FR											
Gremlin (Opt.)	FR											
AMX (Calif.)	FR	4	6IL	OHV	95/99	4228	258	100	3400	8.00	C	W
Concord (Calif.)	FR											
Gremlin (Calif.)	FR											
Pacer (Calif.)	FR											
AMX	FR	4	6IL	OHV	95/99	4228	258	120	3600	8.00	C	W
Matador	FR											
Concord (Opt.)	FR											
Gremlin (Opt.)	FR											
Pacer (Opt.)	FR											
AMX (Opt.)	FR	4	8V	OHV	95/87	4982	304	130	3200	8.40	C	W
Concord (Opt.)	FR											
Pacer (Opt.)	FR											
Matador (Opt.)	FR	4	8V	OHV	104/87	5899	360	140	3500	8.25	C	W
Chrysler												
Dodge Omni (Calif.)	FF	4	4TR	OC	80/86	1714	104.6	70	5500	8.20	C	W
Plymouth Horizon (Calif.)	FF											
Dodge Omni	FF	4	4TR	OC	80/86	1714	104.6	75	5600	8.20	C	W
Plymouth Horizon	FF											
Chrysler LeBaron (Calif.)	FR	4	6IL	OHV	86/105	3687	225	90	3600	8.40	C	W
Dodge Aspen (Calif.)	FR											
Dodge Diplomat (Calif.)	FR											
Plymouth Volaré (Calif.)	FR											
Dodge Aspen	FR	4	6IL	OHV	86/105	3687	225	100	3600	8.40	C	W
Plymouth Volaré	FR											
Chrysler LeBaron	FR	4	6IL	OHV	86/105	3687	225	110	3600	8.40	C	W
Dodge Aspen Wagon	FR											
Dodge Diplomat	FR											
Dodge Monaco	FR											
Plymouth Fury	FR											
Plymouth Volaré Wagon	FR											
Dodge Aspen (Opt.)	FR											
Plymouth Volaré (Opt.)	FR											
Chrysler Cordoba (Opt.)	FR	4	8V	OHV	99/84	5211	318	140	4000	8.50	C	W
Chrysler LeBaron (Opt.)	FR											
Dodge Aspen (Opt.)	FR											
Dodge Charger SE	FR											
Dodge Diplomat (Opt.)	FR											
Dodge Magnum XE	FR											
Dodge Monaco (Opt.)	FR											
Plymouth Fury (Opt.)	FR											
Plymouth Volaré (Opt.)	FR											
Chrysler (All Opt.)	FR	4	8V	OHV	102/91	5899	360	155	3600	8.40	C	W
Dodge Aspen (Opt.)	FR											
Dodge Charger SE (Opt.)	FR											
Dodge Diplomat (Opt.)	FR											
Dodge Magnum XE (Opt.)	FR											
Dodge Monaco (Opt.)	FR											
Dodge Monaco Wagon	FR											
Plymouth Fury (Opt.)	FR											
Plymouth Fury Wagon	FR											
Plymouth Volaré (Opt.)	FR											

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UNITED STATES (Cont'd.)												
Chrysler (Cont'd.)												
Dodge Aspen (Calif.)	FR	4	8V	OHV	102/91	5899	360	160	3600	8.00	C	W
Plymouth Volaré (Calif.)	FR											
Chrysler Cordoba (Calif.)	FR	4	8V	OHV	102/91	5899	360	170	4000	8.40	C	W
Chrysler LeBaron (Calif. Opt.)	FR											
Chrysler Newport (Calif.)	FR											
Chrysler New Yorker (Opt.)	FR											
Dodge Charger SE (Calif. Opt.)	FR											
Dodge Diplomat (Calif.)	FR											
Dodge Magnum XE (Calif. Opt.)	FR											
Dodge Monaco (Calif. Opt.)	FR											
Dodge Monaco Wagon (Calif.)	FR											
Plymouth Fury (Calif. Opt.)	FR											
Plymouth Fury Wagon (Calif.)	FR											
Dodge Aspen Coupe (Opt.)	FR	4	8V	OHV	102/91	5899	360	175	4000	8.00	C	W
Plymouth Volaré Coupe (Opt.)	FR											
Chrysler Cordoba	FR	4	8V	OHV	110/86	6555	400	190	3600	8.20	C	W
Chrysler Newport	FR											
Chrysler New Yorker	FR											
Dodge Charger SE (Opt.)	FR											
Dodge Magnum XE (Opt.)	FR											
Dodge Monaco (Opt.)	FR											
Plymouth Fury (Opt.)	FR											
Chrysler Newport (Calif.)	FR	4	8V	OHV	110/95	7210	440	185	3600	8.20	C	W
Chrysler New Yorker (Calif.)	FR											
Chrysler Newport (Opt.)	FR	4	8V	OHV	110/95	7210	440	195	3600	8.20	C	W
Chrysler New Yorker (Opt.)	FR											
Ford Motor												
Ford Fairmont	FR	4	4IL	OC	96/78	2294	140	88	4800	9.00	C	W
Ford Mustang II	FR											
Ford Mustang II Ghia	FR											
Ford Pinto	FR											
Mercury Bobcat	FR											
Mercury Zephyr	FR											
Ford Pinto (Opt.)	FR	4	6V	OHV	93/69	2799	170.8	90	4200	8.70	C	W
Ford Mustang II (Opt.)	FR											
Ford Mustang II Ghia (Opt.)	FR											
Ford Mustang II Mach I	FR											
Mercury Bobcat (Opt.)	FR											
Ford Fairmont (Opt.)	FR	4	6IL	OHV	94/79	3277	200	85	3600	8.50	C	W
Mercury Zephyr (Opt.)	FR											
Ford Granada	FR	4	6IL	OHV	94/99	4097	250	97	3200	8.50	C	W
Mercury Monarch	FR											
Lincoln Versailles	FR	4	8V	OHV	102/76	4949	302	133	3600	8.40	C	W
Ford Fairmont (Calif.)	FR	4	8V	OHV	102/76	4949	302	133	3600	8.10	C	W
Ford Granada (Calif.)	FR											
Lincoln Versailles (Calif.)	FR											
Mercury Monarch (Calif.)	FR											
Mercury Zephyr (Calif.)	FR											

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** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse

† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts

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Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
UNITED STATES (Cont'd.)												
Ford Motor (Cont'd.)												
Ford LTD	FR	4	8V	OHV	102/76	4949	302	134	3400	8.40	C	W
Ford LTD II	FR											
Ford Thunderbird	FR											
Mercury Cougar	FR											
Ford Fairmont (Opt.)	FR	4	8V	OHV	102/76	4949	302	139	3600	8.40	C	W
Ford Granada (Opt.)	FR											
Ford Mustang II (Opt.)	FR											
Mercury Monarch (Opt.)	FR											
Mercury Zephyr (Opt.)	FR											
Ford LTD (Opt.)	FR	4	8V	OHV	102/89	5752	351	144	3200	8.30	C	W
Ford LTD II (Opt.)	FR											
Ford Thunderbird (Opt.)	FR											
Mercury Cougar (Opt.)	FR											
Ford LTD (Opt.)	FR	4	8V	OHV	102/89	5752	351	145	3400	8.00	C	W
Ford LTD Wagon	FR											
Mercury Marquis	FR											
Ford LTD II (Opt.)	FR	4	8V	OHV	102/89	5752	351	152	3600	8.00	C	W
Ford Thunderbird (Opt.)	FR											
Mercury Cougar (Opt.)	FR											
Ford LTD (Opt.)	FR	4	8V	OHV	102/102	6555	400	160	3800	8.00	C	W
Mercury Marquis (Opt.)	FR											
Ford LTD II (Opt.)	FR	4	8V	OHV	102/102	6555	400	166	3800	8.00	C	W
Ford Thunderbird (Opt.)	FR											
Lincoln Continental	FR											
Lincoln Continental Mark V	FR											
Mercury Cougar (Opt.)	FR											
Ford LTD (Opt.)	FR	4	8V	OHV	111/98	7538	460	202	4000	8.00	C	W
Mercury Marquis (Opt.)	FR											
Lincoln Continental Mark V (Opt.)	FR	4	8V	OHV	111/98	7538	460	210	4200	8.00	C	W
General Motors												
Chevrolet Chevette	FR	4	4IL	OC	82/76	1599	97.7	63	4800	8.60	C	W
Chevrolet Chevette (Opt.)	FR	4	4IL	OC	82/76	1599	97.7	68	5000	8.60	C	W
Chevrolet Monza	FR	4	4IL	OHV	102/76	2474	151	85	4400	8.30	C	W
Oldsmobile Starfire	FR											
Pontiac Phoenix (Opt.)	FR											
Pontiac Sunbird	FR											
Buick Century	FR	4	6V	OHV	89/86	3212	196	90	3600	8.00	C	W
Buick Regal Coupe	FR											
Chevrolet Monza (Opt.)	FR											
Buick Century (Opt.)	FR	4	6V	OHV	89/86	3212	196	95	3800	8.00	C	W
Buick Regal (Opt.)	FR											
Chevrolet Malibu	FR	4	6V	OHV	89/88	3277	200	95	3800	8.20	C	W
Buick Century (Opt.)	FR	4	6V	OHV	97/86	3785	231	105	3400	8.00	C	W
Buick Century Wagon	FR											
Buick Regal (Opt.)	FR											
Buick Skyhawk	FR											
Buick Skylark	FR											
Chevrolet Malibu (Calif.)	FR											
Chevrolet Monte Carlo	FR											
Chevrolet Monza (Calif.)	FR											
Oldsmobile Cutlass	FR											
Oldsmobile Delta 88	FR											
Oldsmobile Omega	FR											

(Cont'd.)

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
UNITED STATES (Cont'd.)												
General Motors (Cont'd.)												
Oldsmobile Starfire (Opt.)	FR	4	6V	OHV	97/86	3785	231	105	3400	8.00	C	W
Pontiac Catalina	FR											
Pontiac Firebird	FR											
Pontiac Firebird Esprit	FR											
Pontiac Grand LeMans	FR											
Pontiac Grand Prix	FR											
Pontiac LeMans	FR											
Pontiac Phoenix	FR											
Pontiac Sunbird (Opt.)	FR											
Buick LeSabre Sport (Turbocharged)	FR	4	6V	OHV	97/86	3785	231	150	3800	8.00	C	W
Buick Regal Sport (Turbocharged)	FR											
Buick LeSabre Sport (Opt.) (Turbocharged)	FR	4	6V	OHV	97/86	3785	231	165	4000	8.00	C	W
Buick Regal Sport (Opt.) (Turbocharged)	FR											
Chevrolet Camaro	FR	4	6V	OHV	98/90	4097	250	110	3800	8.10	C	W
Chevrolet Caprice	FR											
Chevrolet Impala	FR											
Chevrolet Nova	FR											
Oldsmobile Cutlass (Opt.)	FR	4	8V	OHV	89/86	4261	260	110	3400	7.50	C	W
Oldsmobile Delta 88 (Opt.)	FR											
Buick LeSabre (Opt.)	FR	4	8V	OHV	102/76	4932	301	140	3600	8.20	C	W
Pontiac Bonneville	FR											
Pontiac Catalina (Opt.)	FR											
Pontiac Catalina Wagon	FR											
Pontiac Grand Am	FR											
Pontiac Grand Prix (Opt.)	FR											
Pontiac Grand Prix LJ	FR											
Pontiac Grand Am (Opt.)	FR	4	8V	OHV	102/76	4932	301	150	4000	8.20	C	W
Pontiac Grand Prix LJ (Opt.)	FR											
Pontiac Grand Prix SJ	FR											
Pontiac Grand LeMans (Calif.)	FR	4	8V	OHV	95/83	4998	305	135	3800	8.40	C	W
Pontiac Grand Prix (Calif.)	FR											
Pontiac LeMans (Calif.)	FR											
Buick Century (Calif.)	FR	4	8V	OHV	95/83	4998	305	145	3800	8.50	C	W
Buick LeSabre (Calif.)	FR											
Buick Regal (Calif.)	FR											
Buick Skylark (Opt.)	FR											
Chevrolet Camaro (Opt.)	FR											
Chevrolet Caprice (Opt.)	FR											
Chevrolet Caprice Wagon	FR											
Chevrolet Chevelle (Opt.)	FR											
Chevrolet Impala (Opt.)	FR											
Chevrolet Impala Wagon	FR											
Chevrolet Malibu (Opt.)	FR											
Chevrolet Monza (Opt.)	FR											

(Cont'd.)

* FR–Front Engine Rear Drive, FF–Front Engine Front Drive, RR–Rear Engine Rear Drive, MR–Mid Engine Rear Drive
** IL–Inline, V–Vee, HO–Horizontally Opposed, TR–Inline Transverse
† OHV–Overhead Valve, OC–Overhead Camshaft, TOC–Twin Overhead Camshafts
†† G–Gross Rating
‡ Number of Carburetors (C) or Fuel Injection (EFI–Electronic, MFI–Mechanical)
‡‡ A–Air, W–Water or liquid

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
General Motors (Cont'd.)				UNITED STATES (Cont'd.)								
Chevrolet Nova (Opt.)	FR	4	8V	OHV	95/83	4998	305	145	3800	8.50	C	W
Oldsmobile Cutlass (Opt.)	FR											
Oldsmobile Omega (Opt.)	FR											
Oldsmobile Starfire (Opt.)	FR											
Pontiac Firebird (Opt.)	FR											
Pontiac Firebird Esprit (Opt.)	FR											
Pontiac Grand LeMans (Opt.)	FR											
Pontiac LeMans (Opt.)	FR											
Pontiac Phoenix (Opt.)	FR											
Buick Century (Opt.)	FR	4	8V	OHV	95/83	4998	305	160	4000	8.00	C	W
Buick Regal (Opt.)	FR											
Oldsmobile Cutlass (Opt.)	FR											
Cadillac Seville (Opt.) (Diesel)	FR	4	8V	OHV	103/86	5735	350	120	3600	22.50	MFI	W
Oldsmobile Delta 88 (Opt.) (Diesel)	FR											
Oldsmobile 98 (Opt.) (Diesel)	FR											
Oldsmobile Custom Cruiser (Opt.) (Diesel)	FR											
Buick Electra	FR	4	8V	OHV	97/98	5735	350	155	3400	8.00	C	W
Buick Estate Wagon	FR											
Buick LeSabre (Opt.)	FR											
Buick Riviera	FR											
Pontiac Bonneville (Opt.)	FR											
Pontiac Catalina (Opt.)	FR											
Pontiac Grand Safari (Opt.)	FR											
Buick Century (Opt.)	FR	4	8V	OHV	97/98	5735	350	160	4000	8.50	C	W
Oldsmobile Omega (Calif.)	FR	4	8V	OHV	103/86	5735	350	160	3800	8.20	C	W
Pontiac Firebird (Calif.)	FR											
Pontiac Firebird Esprit (Calif.)	FR											
Pontiac Firebird Formula (Calif.)	FR											
Pontiac Phoenix (Opt.)	FR											
Chevrolet Camaro (Opt.)	FR	4	8V	OHV	102/88	5735	350	170	3800	8.20	C	W
Chevrolet Caprice (Opt.)	FR											
Chevrolet Impala (Opt.)	FR											
Cadillac Seville	FR	4	8V	OHV	103/86	5735	350	170	4200	8.00	EFI	W
Oldsmobile Delta 88 (Opt.)	FR	4	8V	OHV	103/86	5735	350	170	3800	8.00	C	W
Oldsmobile 98	FR											
Oldsmobile Custom Cruiser	FR											
Pontiac Bonneville (Calif.)	FR	4	8V	OHV	103/86	5735	350	170	3800	7.90	C	W
Pontiac Catalina (Calif.)	FR											
Pontiac Grand Safari (Calif.)	FR											
Chevrolet Camaro (Opt.)	FR	4	8V	OHV	102/88	5735	350	185	4000	8.20	C	W
Chevrolet Corvette	FR											
Chevrolet Corvette (Opt.)	FR	4	8V	OHV	102/88	5735	350	220	5200	8.90	C	W
Pontiac Bonneville (Opt.)	FR	4	8V	OHV	105/95	6555	400	180	3600	7.70	C	W
Pontiac Catalina (Opt.)	FR											
Pontiac Firebird Formula (Opt.)	FR											
Pontiac Firebird Trans Am	FR											
Pontiac Firebird Formula (Opt.)	FR	4	8V	OHV	105/95	6555	400	220	4000	8.00	C	W
Pontiac Firebird Trans Am (Opt.)	FR											
Pontiac Bonneville (Calif.)	FR	4	8V	OHV	110/86	6604	403	185	3600	7.90	C	W
Pontiac Catalina (Calif.)	FR											
Pontiac Firebird Formula(Calif.)	FR											
Pontiac Firebird TransAm(Calif.)	FR											
Pontiac Grand Safari (Calif.)	FR											

BRIEF SPECIFICATIONS OF 1978 PASSENGER CAR ENGINES

Car Model	Location & Drive*	Cycle	No. Cylinders and Type**	Valve Location†	Bore and Stroke, mm	Piston Displacement cc	Piston Displacement cu. in.	Maximum Brake HP @ RPM Net††	Maximum Brake HP @ RPM RPM	Compression Ratio	Carburetor(s) or Fuel Injection‡	Coolant‡‡
UNITED STATES (Cont'd.)												
General Motors (Cont'd.)												
Buick Electra (Opt.)	FR	4	8V	OHV	110/86	6604	403	185	3600	8.00	C	W
Buick Estate Wagon (Opt.)	FR											
Buick LeSabre (Opt.)	FR											
Buick Riviera (Opt.)	FR											
Oldsmobile Toronado	FF	4	8V	OHV	110/86	6604	403	190	3600	8.00	C	W
Cadillac DeVille	FR	4	8V	OHV	104/83	6964	425	180	4000	8.20	C	W
Cadillac Eldorado	FF											
Cadillac Fleetwood	FR											
Cadillac DeVille (Opt.)	FR	4	8V	OHV	104/83	6964	425	195	3800	8.20	EFI	W
Cadillac Fleetwood (Opt.)	FR											
USSR												
AZLK												
Moskvich 2136	FR	4	4IL	OHV	76/75	1357	82.8	50	4750	7.00	C	W
Moskvich 2138	FR											
Moskvich 2137	FR	4	4IL	OC	82/70	1479	90.3	75	5800	8.80	C	W
Moskvich 2140	FR											
GAZ												
Volga 24 Indenor Diesel	FR	4	4IL	OHV	88/80	1948	118.9	50	4500	21.80	MFI	W
Volga 24 Indenor Diesel	FR	4	4IL	OHV	90/83	2112	128.9	59	4500	22.20	MFI	W
Volga 24 (Opt.)	FR	4	4IL	OHV	92/92	2445	149.2	95G	4700	8.70	C	W
Volga 24	FR	4	4IL	OHV	92/92	2445	149.2	110G	4500	8.20	C	W
Volga 24-02	FR											
Chaika	FR	4	8V	OHV	100/88	5522	337.0	207	4000	8.50	2C	W
VAZ												
Zhiguli 1200 (Lada)	FR	4	4IL	OC	76/66	1198	73.1	60	5600	8.80	C	W
Zhiguli 1300 (Lada)	FR	4	4IL	OC	79/66	1294	79.0	67	5600	8.80	C	W
Zhiguli 1500 (Lada)	FR	4	4IL	OC	76/80	1452	88.6	75	5600	8.80	C	W
Zhiguli 1600 (Lada)	FR	4	4IL	OC	79/80	1568	95.7	78	5200	8.60	C	W
ZAZ												
968-A	RR	4	4V	OHV	76/66	1196	73.0	45	4500	8.40	C	A
ZIL												
114	FR	4	8V	OHV	108/95	6962	424.8	300G	4400	9.00	C	W
117	FR											
YUGOSLAVIA												
ZCZ (Fiat)												
Zastava 750	RR	4	4IL	OHV	62/64	767	46.8	25	4600	7.50	C	W
Zastava 101	FF	4	4TR	OC	80/56	1116	68.1	55	6000	8.80	C	W
Zastava 1300	FR	4	4IL	OHV	72/80	1295	79.0	60	5400	9.00	C	W